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A MANUAL OF OPHTHALMOSCOPY

FOR THE

USE OF STUDENTS

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OF

OPHTHALMOSCOPY

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BY

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TRANSLATED BY

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AUTHOR'S PREFACE.

This little book is dedicated to students and those who are commencing the study of Diseases of the Eye. It is a condensed *résumé* of the Lectures, which I attended for several years, of my illustrious master and friend, Professor Galezowski, and to whom I would testify my gratitude.

My object has been to condense, in as small a number of pages as possible, all that it is necessary to know to study with benefit diseases of the fundus of the eye. I have made a special effort to bring into prominence the value of *functional symptoms;* for they often, by themselves, enable us to

establish a probable diagnosis, which the ophthalmoscope has only to confirm. They, therefore, often constitute excellent guides, which have been but too frequently neglected or misunderstood.

The restricted scope of this work has not permitted the addition of ophthalmoscopic drawings, which it is so useful to consult. I must refer the reader to the excellent Atlas of Professor Perrin, my amiable master at the hospital of Val de Grace.

Dr. Daguenet.

TRANSLATOR'S PREFACE.

The scope and object of this work is so well described in the Author's Preface that there remains little for the Translator to say.

Several years ago the work came into my hands. It seemed to me then to fill a gap which existed in the elementary literature of the Ophthalmoscope, which even now has not been completely filled up. Its portable size, the condensed nature of its text, and the admirably systematic arrangement of its contents render it extremely useful as a pocket manual for students.

With the Author's permission and sanction, I have made certain additions and alterations, which call, however, for no special remarks.

C. S. Jeaffreson.

October 1, 1880,
Newcastle-on-Tyne.

CONTENTS.

PART I.

CHAPTER I.

OPTICAL CONSIDERATIONS.

CHAPTER II.

OPHTHALMOSCOPY.

PART I.—continued.

CHAPTER III.

THE DIFFERENT KINDS OF OPHTHALMOSCOPES.

CHAPTER IV.

PART II.

CHAPTER I.

FUNCTIONAL EXAMINATION OF THE EYE.

PART III.—continued.

CHAPTER II.

AFFECTIONS OF THE OPTIC NERVE.

CHAPTER III.

AFFECTIONS OF THE RETINA.

CHAPTER IV.

CHAPTER V.

AFFECTIONS OF THE VITREOUS BODY.

CHAPTER VI.

AMBLYOPIA AND AMAUROSIS PROPERLY SO-CALLED.

PART III.—continued.

CHAPTER VII.

MANUAL OF OPHTHALMOSCOPY.

PART I.

CHAPTER I.

OPTICAL CONSIDERATIONS.

A FEW words generally upon mirrors and lenses will enable the student to grasp and retain in his memory some of the more important facts contained in the subsequent chapters of this little book. They must of necessity be somewhat brief and disconnected; space will not admit of their being treated in a more comprehensive manner. The intention is to recall to the mind certain salient points, it being understood that the student has some preliminary knowledge of optics, such as may be obtained in any elementary work upon natural philosophy.

The laws of reflection from mirrors chiefly

bear upon the question of ophthalmoscopes and their capacity for illuminating the fundus. The laws of refraction of lenses have a practical application in everything which relates to the eye as an optical instrument. The phenomena relating to distant and close vision, to myopia, hypermetropia, and astigmatism, and all other temporary or permanent defects in the refraction of the eye, cannot be appreciated without a clear understanding of the action of lenses.

With a biconvex lens, a lamp, and white paper screen, the student, in a darkened room, may make many practical experiments in a manner which will leave a clear and lasting impression upon his memory.

Mirrors.—According to the well-known optical law, that the angle of incidence of a ray of light is equal to the angle of reflection, plane mirrors always reflect light, as regards convergence or divergence, in the same direction as it falls upon them. Concave mirrors converge all rays falling upon them from any distance further than their

principal focus. Convex mirrors diverge all rays that fall upon them.

Now, if we take these elementary facts into consideration, we shall see that plane mirrors are ill adapted and rarely used for ophthalmoscopes. If they are illuminated from a distance, the parallel rays which they will throw into the eye, falling upon the lens, will be brought to a focus upon the retina, and will there paint a very minute inverted image of the source of light. The portion of retina illuminated is very small, and the conditions are not favourable for examination. If the plane mirror is illuminated by a lamp placed close to it, the divergent rays from the lamp become still more divergent; on leaving the mirror the light is scattered too much, and the illumination is feeble. *Convex mirrors* produce the same effect, and are also rarely employed for ophthalmoscopic purposes, unless a very powerful source of light is employed, such as the sun. Concave mirrors, which have the effect of converging rays of light, are most adapted, and are usually employed in the construction of ophthalmoscopes. The

light which enters the eye from them being already in a condition of convergence is still further converged by the lens; the rays are rapidly brought to a focus in front of the retina; they cross and illuminate the fundus with a large and brilliant circle of diffusion.

The chief kinds of lenses employed in ophthalmic practice are biconvex, biconcave, and cylindrical lenses.

Biconvex Lenses.—The point at which rays of light coming from infinite distance (6 D.*) are brought to a point or focus by a lens is called the principal focus of the lens. The distance will depend, first, upon the radius of curvature of the refracting surface of the lens; secondly, upon the index of refraction of the substance of which the lens is made. Speaking generally, the shorter the radius of curvature the greater the strength of the lens or its refractive power. By virtue of this law, if in a darkened room a candle is held at 6 D. from a lens, an image of the candle will be painted upon a screen held upon the

* Six metres.

opposite side of the lens, and gradually moved into its principal focus. If the distance between the lens and the screen is now measured, we shall have the measure of the principal focus of this lens. This distance is fixed and definite for each lens, and for rays that come from infinite distance never changes. In a *normal eye*, the retina lies at the principal focus of the dioptric system of the eye, and that is why such an eye sees distant objects without any effort of adjustment.

Now, if the candle in the darkened room is brought nearer to the lens than 6 D., the rays emanating from it are no longer parallel but divergent; we shall, therefore, not find the image of the flame depicted upon the screen clearly; we shall have to remove it farther from the lens before it becomes so. It no longer lies at the principal focus of the lens, but at what is called its conjugate focus. The nearer the candle is brought to the lens, the further off does this conjugate focus recede.

Now, if we apply these laws to the eye, it is clear that when an object is nearer to it

than 6 D. a clear impression or image of it would not be depicted upon the retina, because the conjugate focus for nearer objects would lie behind the retina. Unless, therefore, there were some mechanism by which the retina could be removed to a greater distance, or what amounts practically to the same thing, the convergent power of the lens could be increased, we should never see clearly close objects. Fortunately, this mechanism for increasing the converging power of the lens does exist, and is called the power of accommodation. It is important to bear these elementary facts constantly in mind, and it will be seen how they practically relate to many ophthalmic questions. Normal eyes have their retina situated at the principal focus of their dioptric systems. Myopic eyes have their retina situated at a greater distance than the principal focus of their dioptric system; therefore the objects must be brought nearer, so that the conjugate focus may fall upon the retina; the nearer they are brought the further off is the conjugate focus, and in this way we may measure roughly the degree of myopia.

In hypermetropia the retina does not lie at the principal focus of the lens, but in front of it. The subjects of it cannot therefore see distant objects or closer ones when *their eyes are at rest;* but by using their accommodation they can generally increase so much their lens-power as to make the principal focus coincide with the retina.

But to return to our darkened room. Supposing the candle is gradually brought still nearer to the lens, till in fact it comes to lie at a distance equal to its principal focus, what happens? The rays of light which emanate on the other side of the lens will be practically parallel, and the image of the flame will lie at infinite distance.

If we bring the candle still nearer yet, and it comes to lie at some distance within the principal focus, the character of the lens, as a converger of light, is changed. It then plays the part of a magnifying glass; and an observer situated upon the opposite side of the lens will perceive an enlarged and erect image of the candle, the amount of the enlargement depending upon the closeness with

which it is approached, and the refractive power of the lens employed. The focus of the lens, which is now called a virtual focus, is upon the same side as the flame.

Concave Lenses have the opposite action to that of convex lenses. Instead of converging the rays of light which pass through them, they diverge them. Their focus, which is a negative or virtual focus, lies upon the same side as the source of light, and at a distance which varies according to the strength of the lens, or, in other words, the curvature of its refractive surface. The following diagrams (Figs. 1 and 2) will illustrate the relationship of convex and concave lenses.

Convex and concave lenses, whose surfaces have the same radii of curvature, and which are made of material with the same index of refraction, neutralize each other when placed in contact.

Fig. 1 represents the action of a convex lens. If A B is a lens of 3‴ focus, C being a candle in a darkened room, P P P P P are the parallel rays given off by the light. In

passing through A B they are converged, and paint an inverted image of the candle at D, which will be situated at 3‴ from A B, and is the *principal focus* of the lens, and is on the opposite side of the lens to the source of light. Now, if the candle be removed from C to A′ B′ the rays

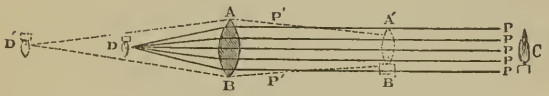


Fig. 1.

it gives off are no longer parallel, but divergent, P′ P′. They are brought to a focus at D′, which is called the conjugate focus, and is further from A B than the principal focus.

Fig. 2.—In this figure, if A B represents a concave lens of 3‴ focus, and C represents the

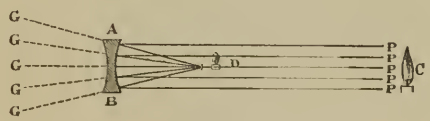


Fig. 2.

candle at infinite distance, the parallel rays P P P P P, on arriving at the lens, are diverged in the direction G G G G G. They unite at D, and

then form a virtual erect image of the candle, D. This point D is the principal focus of the lens A B, and is situated at 3″ from it.

Cylindrical Lenses. — Whilst spherical glasses have an equal power of refraction in all their diameters or segments, cylindrical glasses refract only in one diameter.

They are, in fact, sections of cylinders, convex or concave as the case may be, as seen in Figs. 3 and 4. As they refract only the rays which fall upon them in a plane at right angles to the axis of their curvature, that is at right angles to the axis of the cylinder, they have no focus as spherical lenses have.

The laws of refraction, as applied to spherical, concave, and convex lenses, hold good for cylindrical lenses only in one plane, viz., that at right angles to the axis of the cylinder.

The recollection of these data will at once suggest the practical application of these lenses, when, as in astigmatism, there is an unequal power of refraction in different segments of the eye. Supposing the vertical

meridian of an eye to be defective in refractive power, it would require for its correction a positive cylindrical glass placed before the eye, with its axis at right angles to the vertical meridian; that is to say, with its axis horizontal. If the horizontal meridian is defective in refractive power, the correcting cylindrical must have its axis vertical.

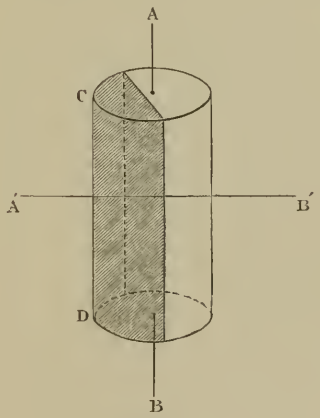


Fig. 3.

Fig. 3 represents a segment of a cylinder, the axis of which is A B. Rays of light falling upon the surface C D, in the direction

of the axis A B, will not be acted upon, but those falling in the direction A′ B′, at right angles to A B, will be brought to a focus in the same way as though they passed through a segment of a spherical lens.

Fig. 4 represents a segment of a hollow

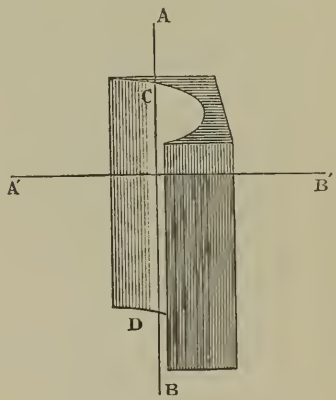


Fig. 4.

cylinder or concave cylindrical lens, of which A B is the axis. Rays falling upon the surface C D, in the direction of A B, will undergo no refraction, but those in the direction of A′ B′,

at right angles to A B, will be diverged, as though they passed through a segment of concave spherical lens of equal power.

The Numbering of Lenses.—In speaking of the strength of lenses, it is necessary to have some fixed or standard glass, which forms a basis of comparison for others. Formerly this unity of value was a glass whose radius of curvature was one inch, and whose focal distance was also one inch, if the index of refraction of the glass was as it should be.

This system, which up to recent years was constantly employed in this country, has many inconveniences. (1) The unity of glass, one inch focus, is one which we seldom employ on account of its strength. The glasses in use are all weaker than the unity, and had therefore to be expressed in fractions; thus complicating to a certain extent calculations concerning them. (2) The inches of different countries did not correspond. (3) The intervals of strength or refractive power between the different lenses was very unequal.

At the Ophthalmological Congress, held in

Heidelberg, in 1875, it was resolved to adopt a new system of numbering, based upon the metrical foundation. Almost all the principal oculists of Europe agreed to adopt it. Its principal data are as follows:—(1) The metre to be substituted for the inch as the unit of comparison. (2) The number of the glass to indicate its refractive power, and not its focal length or radius of curvature.

According to this system, then, a glass having a refractive power of one metre (dioptry it is called for ophthalmic purposes), is the No. 1, or 1 D., of the series. The No. 2 is a glass having twice the refractive power of No. 1; No. 2 D. it is called. No. 3 D. has three times the refractive power of No. 1, and so on.

By thus following the simple cardinal numbers, we have a series of lenses having the same interval of strength between them, namely, 1 D.

The relation of the old series to the new is a matter of very easy calculation, when we bear in mind that a metre corresponds to a distance of forty English inches.

A lens of 1 D. equals, then, the $\frac{1}{40}$ of the

old series; one of 2 D. equals $\frac{2}{40} = \frac{1}{20}$; 3 D. $= \frac{3}{40} = \frac{1}{13}$ nearly, and so on.

It is true that a lens of less value than 1 D. is required; but should it be so, there are lenses of 0·75 D., 0·25 D., and 0·5 D.

One of the great advantages of this system is, that in almost all necessary calculations whole numbers can be employed, and that in all cases the interval between any two numbers of glasses can be found by the subtraction of whole numbers or decimals.

The corresponding number in the old notation of a given glass of the metrical system can always be obtained by the following formula:—

If we call the number of dioptrics D., and the number of old system N., then

$$N. = \frac{40}{D.}$$

Thus we have a glass, say of 8 D., and we wish to ascertain its value by the old notation.

$$\frac{40}{8} = 5$$

8 D., then, equal $\frac{1}{5}$ of the old series.

A glass of 10 D.—

$$\frac{40}{10} = 4$$

10 D., then, equal $\frac{1}{4}$ of old series.

Inversely, knowing the old number, we wish to find the number of dioptrics corresponding to it, we simply reverse the equation.

If N. equals the old number, and D. the number of dioptrics,

$$D. = \frac{40}{N.}$$

Thus, we have a $\frac{1}{8}$ of old series, and we wish to ascertain its value—

$$\frac{40}{8} = 5$$

$\frac{1}{8}$, therefore, equals 5 D.

Or an old $\frac{1}{10}$ —

$$\frac{40}{10} = 4$$

$\frac{1}{10}$ of old series, therefore, equals 4 D.

CHAPTER II.

OPHTHALMOSCOPY.

The ophthalmoscope, invented by Helmholtz in 1851, is an instrument designed for the illumination of the fundus of the eye, and to enable us to see an image of it. It is composed essentially of two parts—(1) a concave mirror, pierced by a small central orifice; (2) a strong biconvex lens, of $2\frac{1}{2}$ or 3 in. focus.

The eye may be lighted up with either of these parts used separately, or in combination. Lateral, or oblique, illumination, is practised when the lens is used alone. An ophthalmoscopic examination, properly so called, is made when the mirror is used, either alone, or in combination with the lens.

ARTICLE I.

OBLIQUE ILLUMINATION.

This method of illumination does not form any part of ophthalmoscopy, properly so called.

It is exclusively used in an examination of the anterior hemisphere of the eye. By this means we can carefully overlook (1) the cornea, (2) the anterior chamber, (3) the iris and pupillary orifice, (4) the crystalline lens, (5) the most anterior portions of the vitreous body.

To put it into practice, the room must be darkened, and a lamp must be placed on one side of the patient, on a level with his eye, and about three feet off. By means of the biconvex lens, we concentrate upon the anterior hemisphere of the eye, the summit of the luminous cone furnished by the rays emanating from the lamp. Then, by means of slight displacements of the lens, we cause it to pass over the whole surface of the cornea, which becomes brilliantly illuminated.

The observer can now perceive the most minute alterations in the transparent media. To render these changes more evident, and to enlarge the image, he can make use of a second convex lens, after the method of an ordinary magnifying glass.

ARTICLE II.

OPHTHALMOSCOPIC ILLUMINATION.

Theory of the Ophthalmoscope.— The reason that we see nothing of the fundus of the eye under ordinary conditions, is chiefly because it is not sufficiently lighted up. In order to see it, we must first throw light into the interior of the eye; secondly, put our own eye in the path of the luminous rays which are emanating from it, without at the same time intercepting those which are entering it.

To fulfil these conditions we make use of a concave mirror pierced with a small central orifice, behind which the examiner's eye can be adapted without interfering with the illumination. This mirror throws into the eye convergent rays, which, uniting considerably in front of the retina, cross each other and continue divergently, and form a circle of diffusion, which illuminates a great part of the fundus of the eye.

If we used a plane mirror, this would throw into the eye no longer convergent rays, but

parallel rays, which would be united upon the retina in a focus, and there paint an inverted image of the source of light. This image would be brilliant, but too small for practical use. The method of illuminating by the projection of luminous images is not a favourable condition. When we make use of the mirror, associated with the lens, the conditions of the illumination of the eye vary. If the latter is held at a distance from the eye, a little in excess of its focal distance, it unites at its focus, or, more strictly speaking, somewhat in front of its focus, the already converging rays which are sent to it by the mirror. These rays unite, cross each other, and enter the eye with such an amount of divergence that they cannot be united upon the retina, which they consequently illuminate with a large circle of diffusion.

The fundus of the eye once illuminated with the mirror appears of a beautiful red colour and strikingly brilliant. It may be looked upon as a luminous source, which throws off rays in every direction. But how is it that we have still but a confused image?

How is it we do not see distinctly the papilla, or the retinal vessels, or any of the details of the fundus? It is because in front of the retina there are certain refracting media, which refract, in many different ways, the luminous rays emanating from the retina, according as the latter may lie exactly at the focus of the refracting media (the emmetropic eye), beyond this focus (myopia), or in front of this focus (hypermetropia).

This direction of the luminous rays is one of the most important things to thoroughly understand. The theory of lenses seems readily to explain it. Let us suppose now that the power of accommodation of the eye is thoroughly relaxed, or in abeyance.

Emmetropic Eye.—We know that a biconvex lens unites at its principal focus luminous rays coming from an infinite distance, or from a distance sufficient that the rays may be practically parallel (20 ft.). For this reason, the rays of light from external objects, under these conditions, are united upon the retina, and paint there a small and inverted real image of the figure from which they emanate.

Inversely, if the source of light is at the principal focus of the lens, the rays which traverse this lens leave it parallel, and a real image, inverted and largely magnified, is produced at an infinite distance.

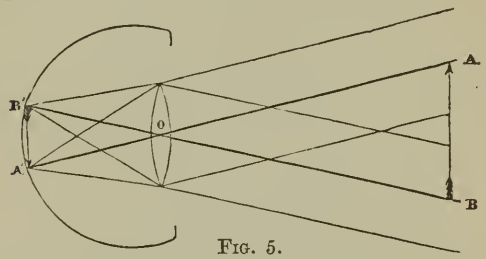


Fig. 5.

To construct a diagram which will indicate the direction of light under these circumstances, we draw from the extremity of the object the secondary optic axes A O A', B O B', passing through the optical centre of the eye. It is in relation to these axes that the rays are called parallel, convergent, or divergent. Thus, in our example the rays emanating from A are at such a distance that they may be considered as parallel to the axis A O A'. Inversely, those emanating from A' leave the eye parallel to this axis, and theoretically are united in infinity.

Let us apply these data to the subject we are studying. We now understand that luminous rays leave an emmetropic eye in a state of parallelism, and consequently the image of the retina is painted at an infinite distance. If the observer is emmetropic himself, and does not use his accommodation, theoretically, he will unite upon his retina these parallel rays, and get an erect image of the fundus. But how are we to avoid using the accommodation whilst looking so closely? Practically it is impossible, and thus the examiner will never get a distinct image of the emmetropic eye unaided. There is, however, paradoxical as it may seem, an exception to this rule. When we approach very near to the observed eye, that is within three or four centimetres, we often see the fundus of this eye. This is explained by Mr. Power on the grounds that "contrary to what theory would presuppose, the accommodation is relaxed on both sides, no doubt from the fact that the examiner and the examined are not sufficiently separated from each other to come within the limits of distinct vision.

Myopic Eye.—When the source of light, instead of being placed at infinite distance, is nearer, parallel rays are no longer given off, but divergent ones. These become united no longer at the principal focus of the lens, but beyond it, at a point called the conjugate focus, and which is situated at a greater distance the nearer the luminous source is brought to the lens. It is at one of the

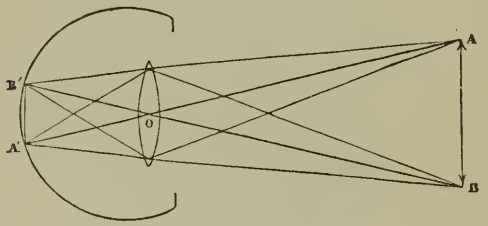


Fig. 6.

conjugate foci of the dioptric system that the retina of the myopic eye is situated. It is for such a reason that such an eye can only see near objects.

Inversely, when the source of light is situated at the conjugate focus of such a lens or dioptric system, the rays passing

through this system are no longer parallel, but convergent, as the annexed figure will show.

The reasons are thus:

Luminous rays from the fundus of a myopic eye always leave it in a state of convergence. Now our eye is so constructed that it cannot adapt itself for convergent rays, which must, of necessity, become united in front of the retina (unless the examining eye is hypermetropic). The retinal image, then, cannot be seen.

A different state of things comes to pass in very high degrees of myopia, for the luminous rays in these cases emanate from the eye in such a high state of convergence, that they soon meet in a focus in front of the observed eye, and form at that spot a real inverted image of the fundus of the eye. From this, divergent rays proceed in all directions, and in this way we are able to perceive the picture of the retina.

But if things come to pass after this fashion, you will ask, how is it that we do not see the real and inverted image of emmetropic eyes,

when they accommodate for short distances? for, under these circumstances, the rays which emanate from them are also convergent, owing to the power of accommodation. In practice it is not possible, because the accommodation never remains fixed, and varies each instant; this further necessitates a contraction of the pupil, which diminishes the illumination. On the other hand, if we dilate the pupil with atropine, all accommodation is destroyed.

Hypermetropic Eye.—When the source of light is placed at any point between the principal focus and the lens, the latter plays the part of a magnifying glass (Fig. 7).

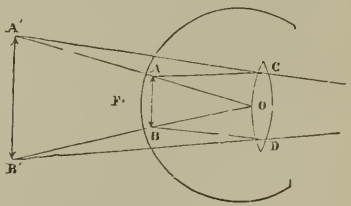


Fig. 7.

Let A B be an object placed within the principal focus F, and the secondary optic

axes A O, B O. The ray A C, after being refracted, will leave the lens divergently in relation to the axis A O. If we imagine it prolonged in a sense contrary to its direction, we shall see that it will meet the axis A O at the point A′. It is from this point that it will appear to come to the eye, which receives an impression of it. And in the same way the point B will appear to come from B′. We shall thus no longer have a real image, but a virtual and enlarged image of A B. The hypermetropic eye realizes these conditions. The rays emanate from it in a state of divergence. The observer, by putting his accommodation into play, will be able to unite them upon his retina, in absolutely the same way that he unites divergent rays coming from any surrounding objects. He will, in this way, see an erect image of the fundus.

To sum up these data. It results that with the mirror alone we can get no distinct image of the fundus of the emmetropic eye, unless it be under certain very special conditions; whilst, on the other hand, we get a real inverted image of the myopic eye,

and a virtual erect image of the hypermetropic one.

The services to which the mirror alone can be placed, are, then, limited and variable. It is for this reason that by means of convex and concave lenses it has been sought to modify or alter the direction of the luminous rays emanating from the fundus of the eye, so as to be able to obtain either an inverted image, or an erect image, at the will of the observer, and from these considerations emanated the two methods of examination by the inverted and the erect image.

Method of the Inverted Image.—It consists in placing a strong biconvex lens before the eye to be examined. This does not serve the purpose of a glass to enlarge objects. It acts by causing the luminous rays emanating from the eye to converge, bringing to its focus, or near its focus, an inverted aerial image of the fundus, much diminished in size, but close to the eye; it retains it in one position, known beforehand, and easily situated for examination (Fig. 8).

With a powerful lens we always obtain a real and inverted image of the fundus of the eye, but this image varies a little in its position and in its size, according as the eye is

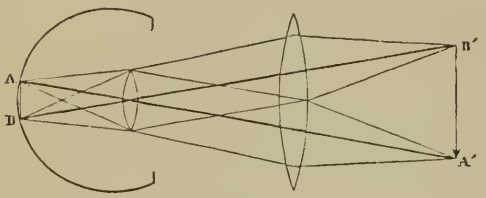


Fig. 8.

emmetropic, hypermetropic, or myopic, or, in other words, according as the luminous rays which emanate from it are parallel, convergent, or divergent.

Thus, the lens, acting upon parallel rays, causes them to converge to its principal focus. If it acts upon convergent rays, it unites them before its principal focus. If, on the other hand, the rays are divergent, part of its strength will be used up in rendering them parallel, the remainder in converging them to a focus. It can then only unite them beyond

its principal focus, that is, at a greater distance from the observed eye.

It is from these considerations that, in relation to the emmetropic eye, the papilla of the myopic eye appears smaller, that of the hypermetropic eye larger.

Method of the Erect Image.—It consists in placing a strong concave lens in the course of the luminous rays emanating from the examined eye (Fig. 9).

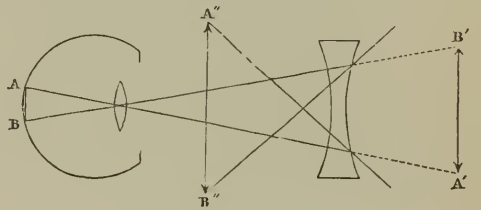


Fig. 9.

Let A B be the retinal image, and A′ B′ its inverted image. If a concave lens of 8 or 10 focus is placed between the observed eye and this image, the rays which pass through it will have a divergence, as though they come from 8 or 10 inches. No real

image is any longer possible, but we obtain an erect and enlarged virtual image A″ B″, situated behind the examined eye. To obtain this erect image, the concave lens is placed behind the aperture in the mirror, and the latter is brought quite close to the observed eye.

Difference between the Inverted and Erect Image.—The inverted image obtained by our ordinary lenses diminishes the very much enlarged image of the retina, but still enables us to see it four or five times as big as it is in reality. It is the most usually employed, because it gives a more general view of the fundus of the eye. The erect image enlarges the image about fourteen diameters; it shows the most delicate alterations in the fundus of the eye, but it only shows a small portion of it at a time.

The real and the inverted image may be distinguished from each other by the different movements which they execute under certain conditions. (*See* Ophthalmoscopic Diagnosis of Errors of Refraction.)

CHAPTER III.

THE DIFFERENT VARIETIES OF OPHTHALMOSCOPES.

The number of ophthalmoscopes is so great that their enumeration would be as long as it would be superfluous. There are two principal varieties—(1) fixed ophthalmoscopes; (2) moveable ophthalmoscopes.

Moveable Ophthalmoscopes are those in which the mirror and the lens constitute two independent and separate parts; they are the most employed on account of the ease with which they are carried, and the facility with which they can be worked. Helmholtz used a plane glass. Reute first used the concave mirror; and it is this kind of ophthalmoscope which is most usually adopted.

Amongst other forms having concave mirrors we may enumerate those of Liebreich, Follin, Desmarres, Perrin, and Galezowski.

Perrin's ophthalmoscope consists of a concave mirror, of about 20 centimetres focus, made of cut glass. The central portion is left transparent for a space about 4 millimetres in diameter; behind is a little framework, destined to receive the convex and concave lenses in ordinary use.

The concave glasses are used for the erect image; the numbers most ordinarily in use are -5 D., 3 D., 2·5 D., -8, -12, and -16. The convex glasses are chiefly used to enlarge the images made by the inverting lens; the numbers most in use are $+5$ D., 2 D., $+8$ and $+16$.

As for the inverting lens, it should be from 2 to $2\frac{1}{2}$ or 3″ in focus. The stronger it is, $+20$ D. to $+13$ D., the nearer to itself does it concentrate the luminous rays, and the smaller and brighter the image is.

Binocular Ophthalmoscope.—A happy idea realized by Giraud Teulon was the adaptation of both eyes simultaneously to ophthalmoscopic exploration. We thus get the sensation of relief, and we can easily make

out the inequalities of level which may be met with in the fundus of the eye, thus interpreting with greater facility many of its alterations.

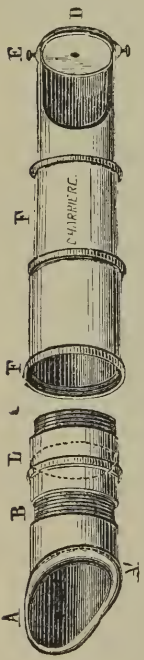


Fig. 10.

Fixed Ophthalmoscopes are those in which the mirror and the lens are adapted upon a common support, which fixes their respective positions. They are very useful for demonstrations, and enable the fundus to be shown to an inexperienced operator. Their inconveniences are, that ordinarily they require artificial dilatation of the pupil, and a perfect immobility in the eye of the patient, which it is often difficult to secure. The most used in France are those of Follin and Galezowski (Fig. 10).

The ophthalmoscope of Galezowski has the special advantage of being able to be used at the bedside, without its being necessary to

use a darkened room, the tube, which constitutes the essential portion of the instrument, forming a darkened chamber. A very similar instrument is known in England under the name of Beale's ophthalmoscope, but many little inconveniences in the use of these instruments has prevented their general adoption.

Most Convenient Form of Ophthalmoscope.—The ophthalmoscope, perhaps, in most general use in this country, is the one known as Liebreich's. A description of it here would be unnecessary, as it may be found at almost any opticians or instrument makers. It is a very good form of instrument for the inverted image, but for the erect examination, which is a far more important matter, it is not so well adapted. The instrument which I should most confidently recommend to students is that known as Loring's modified by Oldham. It consists of a concave mirror of silvered glass of about fifty centimetres focus. There are three separate Rekoss's discs, containing glasses of various strengths, either of which may be adjusted behind the central aperture by

means of a spring. There are many advantages in this instrument which make it very valuable as one for all general purposes. The mirror is not too concave, which

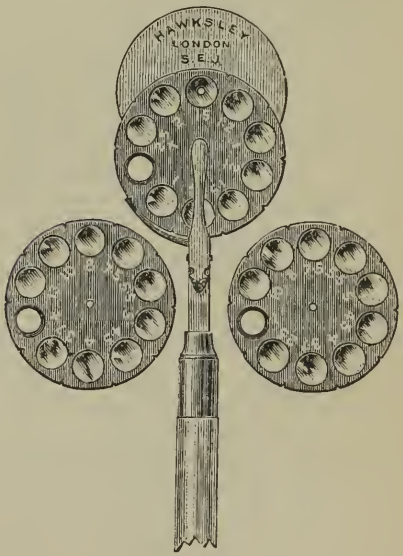


Fig. 11.

is a fault in many cheap instruments, nor is the aperture too large. The handle is long, so that the hand is kept well out of the way in examinations, and the faces of

the observer and observed can be closely approached. The discs are easily adjusted, and the glasses in them are readily kept clean. The handle of the instrument unscrews in the centre, and the whole packs into a convenient little purse, which occupies but little space in the pocket. With a view to simplify and reduce the parts of the instrument, many inventors, by super-posing two discs, each containing glasses of different refractive powers, have obtained a third series of lenses of such suitable strength as to obviate the necessity of having separate and removable discs. Amongst others, I myself had one of the first instruments constructed upon this principle in the year 1870. Since the introduction of the metrical system, the adaptation of this principle has been much facilitated, the refractive power of the glasses being separated by definite intervals, and ophthalmoscopes constructed upon this principle have come into general use. The one, perhaps, more generally adopted in England is Wecker's. My preference is still, however, for the old form of Loring's as modified by Oldham.

CHAPTER IV.

RULES TO BE FOLLOWED IN THE USE OF THE OPHTHALMOSCOPE.

We give, in this chapter, a brief summary of the practical conditions it is necessary to fulfil to see the fundus of the eye with the ophthalmoscope.

Darkened Room.—It is absolutely necessary to practise this method of examination in a darkened room. Without this condition is fulfilled, the ærial image of the retina, less brilliantly illuminated than the surrounding space, would pass unperceived.

Artificial Dilatation of the Pupil.—By instilling into the eye two or three drops of a weak solution of sulphate of atropine, we obtain, in about a quarter of an hour, artificial dilatation of the pupil. This dilatation is useful to beginners, for the examin-

ation of the fundus is much facilitated by it when the pupil is much contracted; when the eye is amaurotic (for then atropine can have no deleterious effect); when it is necessary to examine the macula (for this part of the retina being very sensitive, provokes, by reflex action, an extreme narrowing of the pupil); finally, when we wish to make use of fixed ophthalmoscopes. We should always, however, try, at as early a period as possible, to do without it, on account of the disturbance of vision which it provokes, and the serious inconveniences which sometimes result from its use, especially in cases of glaucoma. In many cases the use of atropine produces very disagreeable and irritating effects, and we may advantageously substitute for it a solution of Duboisine, in the strength of two to three grains to the ounce.

Position of the Light.—The artificial light employed may be that of an ordinary gas or oil lamp. The luminous source must be placed upon one side, and slightly behind the patient, so that the face may not

be illuminated, and it should be about on a level with the patient's eye. It should be brought as close as convenient in the examination by the erect image, or with fixed ophthalmoscopes.

Position of the Observer and the Observed.—The observer places himself in front of the observed upon a seat relatively a little higher, and at a distance of about 40 centimetres. The patient directs his eye in the following manner:—If the right eye is to be examined, he must look in the direction of the right ear of the observer, placed in front of him; for the left eye he must look at the left ear.

The object of this turning of the globe is to bring in front of the observer the papilla, which is not situated upon the antero-posterior axis of the eye, but a little within and below this point.

Position of the Mirror.—The observer holds the mirror in his right hand and places it before his right eye, letting it have a

resting point on the superior margin of the orbit. By means of slight movements he then tries to throw the light reflected from the lamp upon the observed eye, and keep it in the same position. The information which the mirror by itself imparts is very important. It enables us to judge of the transparency of the media and of the condition of refraction.

Position of the Lens.—The left hand of the observer, resting the two last fingers upon the margin of the orbit, holds the lens between the finger and thumb vertically in front of the examined eye, at a distance slightly in excess of its focal distance, for this reason: at this distance the anterior parts of the globe (iris, vessels of the conjunctiva, etc.) are not clearly seen. If the lens is brought too close it plays the part of a magnifying glass, and gives a magnified image of these parts. The attention of the observer being drawn to this, he does not accommodate sufficiently to see the image of the fundus, which being placed at the

principal focus of the lens, is much nearer to him.

Fig. 12.

These different conditions being fulfilled, we look at first for the papilla; afterwards we explore the outlying portions of the fundus by following up the larger retinal vessels.

First attempts with the ophthalmoscope are always attended with some difficulties, the chief one being the faulty direction of the examined eye. It is advisable to practise at first with the artificial eye of Perrin or Remy.

PART II.

CHAPTER I.

FUNCTIONAL EXAMINATION OF THE EYE.

The functional examination of the eye presents for study—(1) central vision; (2) peripheral vision; (3) phosphenes; (4) sensibility of the retina to different colours; (5) its sensibility to light of different intensity (hemeralopia, nyctalopia).

Central Vision.—When, one eye being shut, we look with the other at any given point, we perceive not only this point (central vision), but besides, though in a less distinct manner, the objects which surround it (peripheric vision).

Central vision has its seat in the macula. It is by means of it that we are able to read and write, and see the most minute details of fine objects.

Peripheral Vision has its seat in the rest of the retina. It is scarcely less important than the former; it is by means of it that we have a knowledge of locality, that we are enabled to find our way about, and by its means we get a general view of objects upon which the eye is not immediately fixed.

These two kinds of vision are sometimes quite independent of each other. Thus, certain affections abolish central vision (affections of the macula), leaving peripheric vision in its integrity. The patient, under these circumstances, can only read the largest type, but finds his way in the streets perfectly. Other affections, on the other hand, destroy peripheric vision, and leave the central sight unaffected (retinitis pigmentosa, certain forms of glaucoma). In these cases we see the remarkable condition of patients, who, though able to read the finest print, are incapable of finding their way in the streets, or to avoid obstacles, so contracted is their field of vision. They are in the position of a person who should attempt to go about with a long narrow tube placed before the eye.

ARTICLE I.

CENTRAL VISION—ACUITY OF VISION—TYPOGRAPHIC SCALES OR TEST-TYPES.

Central Vision, or visual acuity, is minuteness of sight, and has nothing to do with the distance of vision, which entirely depends upon the refraction of the eye.

The acuity of vision may be mathematically appreciated by means of typographic scales or graduated test-types. Jaeger, of Vienna, was the first person who proposed these types. In his scale, composed of twenty numbers, No. 1 is half a millimetre in height, and No. 20 two centimetres. These tests, though a great improvement, were open to several objections. Their basis of acuity rested upon no scientific basis; no regular progression followed the different numbers.

Giraud Teulon and Snellen constructed more perfect ones.

Giraud Teulon chose for his unit of distance the length of one foot, and for his unit of size the smallest object the normal

eye could distinguish at that distance. Repeated experiments proved that letters of one-tenth of a millimetre in thickness, separated by the same intervals, fulfilled this condition.

Such is the physiological basis which served as his starting point. This basis is founded upon anatomical grounds, for the following reason:—The smallest image which we are enabled to perceive is that which is capable of forming an impression on one of the nervous elements of the retina alone. Now it has been found by calculation that the transverse measurement of an image of one-tenth of a millimetre, seen at a distance of one foot, subtends on the retina an angle of one minute, or an arc of five-thousandths of a millimetre, which is exactly the diameter of one of the cones which form the nervous sensitive elements of the macula.

Visual Angle.—It is by means of the visual angle that these calculations have been established. The angle A O B (Fig. 13) is formed by two lines drawn from the

extremities of the fixed object to the optical centre of the eye. If these two lines are prolonged they cross each other, and form another angle, A′ o B′, equal to the first, but opposed to it at its summit. It is easy to

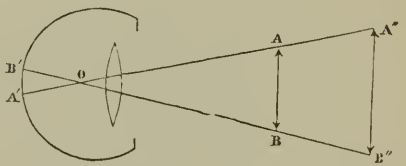


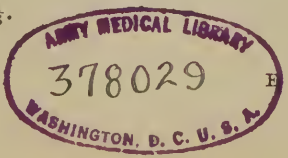
Fig. 13.

calculate this angle as well as the one that it subtends, as the distance between the retina and the point o is already known.

Since the introduction of the metrical system, an alteration has taken place in the numbering of the types of Snellen. The number now no longer indicates in feet the distance at which these types should be clearly visible, but in dioptrics. The numbers commence with 0·5, which should be legible at five decimetres, or half a dioptric, and gradually increase to 60 D., or letters which should be visible at 60 metres.

Graduation of the Scale.—The unity of size being once chosen, the scale has been graduated in the most simple manner. No. 2 is double the size of No. 1, No. 3 is three times the size, and so on. The construction of Figure 13 shows that all objects placed between the two lines of the visual angle, and measuring the amount of their separation, subtend the same angle upon the retina, for their quantities must be proportional. It results from this that No. 2 at two feet and No. 3 at 3 feet subtend the same arc upon the retina as No. 1 at one foot.

Formula of Donders.—This is the method in which the test-types are used for measuring the acuteness of vision. We look upon the person as having normal vision who can read No. 1 at one foot. He who at one foot can only read the letters that are two or three times as large (Nos. 2 and 3) has visual powers two or three times as weak as No. 1, or as it is expressed—Vision $= \frac{1}{2}$, $= \frac{1}{3}$.



Making of these examples a general formula, Donders gives the following equation—

$$S. = \frac{D.}{N.}$$

S. expresses the acuteness of vision, D. the distance at which the type is placed, measured in feet, N. the number of the smallest type the person can read at that distance.

If D. = 1 foot and N. = 5, then S. = $\frac{1}{5}$. If D. = 10 feet and N. = 20, then S. = $\frac{10}{20} = \frac{1}{2}$.

In measuring acuteness of vision, we must be careful not to attribute to any weakening of the sensitive elements of the retina visual troubles which may result from defects of refraction or accommodation, and we should, before expressing the acuteness of vision, neutralize these defects with their appropriate glasses.

Up to twenty years of age the acuteness of vision is slightly in excess of the limit of the scale. It gradually, however, diminishes with age, but not to any material extent, for at eighty years of age No. 2 should still be legible at one foot, where the insufficiency of

the accommodation incident to that period of life has been corrected.

ARTICLE II.

PERIPHERAL VISION—VISUAL FIELD.

The visual field, or field of vision, is the whole space we overlook when both eyes are open and directed upon an object.

As light is propagated in straight lines, it is easy to conceive how each part of the retina is lighted up by rays which come to it in a direction diametrically opposed to the position of that part. Thus, the upper part of the retina receives rays which come from below, and inversely the lower part receives rays which come from above.

The field of vision should be studied in each eye separately.

Limits.—Its extent is most considerable on the outer side. Above it is limited by the eye-brow; inwardly, by the projection of the nose. Its limits are not represented by a

circle, but by an ellipse measuring about 160° in the vertical direction, and 175° in the horizontal.

Measurement of the Field of Vision.—There are several different methods of accomplishing this. 1. Place the patient at 50 centimetres from a blackboard, in the centre of which has been traced a small cross with a piece of white chalk. One eye is to be shut and the other is to be constantly fixed upon this cross. The examiner now gradually approaches from the periphery towards the centre, a piece of chalk, which he holds between his finger and thumb, and marks upon the board the spot where it comes into sight. It determines thus the limits of the four cardinal points, then some intermediate points, and thus gradually maps out the whole field of vision.

2. Another method, less perfect, but more expeditious, is the following. The patient, having one eye closed, looks with the other eye at the observer, placed in front of him. The latter moves his hand rapidly in different parts of the field of vision, ascertains if these

movements are seen, and thus approximately, but often with sufficient exactitude, maps out the field of vision.

3. There are cases, as, for instance, in cataractous patients, where the exploration of the field of vision must be made in a dark room, by means of two lamps, one serving as a fixing point, the other being moved in different directions, to ascertain if the retina has remained healthy.

4. Finally, several authorities (Foster, Wecker, Jeaffreson, and others) have invented special apparatus. These instruments have great precision, but they are not indispensable in practice.

Alterations of the Visual Field.

The visual field is often altered in its extent. We note—

1. Concentric contractions of the field.
2. Abolition of half, under the different forms of hemiopia.
3. Gaps in the field, or scotomata.
4. Entoptic images.

1. **Concentric Contraction.** — Regular concentric contraction of the field of vision is chiefly met with in cases of retinitis pigmentosa. The contraction is more irregular in cases of atrophy of the papilla. In glaucoma it usually commences, and is often limited to the inner side. Subsequently it becomes concentric.

2. **Hemiopia.**—Hemiopia exists when one half of the retina is paralysed, be it in the vertical or horizontal direction.

1. Horizontal hemiopia is usually the result of some ocular affection, such as detachment of the retina, hemorrhage, or exudations in the more dependent parts of the vitreous. It is always monocular.
2. Vertical hemiopia is due to cerebral causes; it is binocular, and is the form of hemiopia most deserving of study. It is homonymous, or crossed.

In homonymous hemiopia the visual field is abolished on the same side of both eyes, either right or left. The patient turns his head on one side to look at objects placed in front of

him, as is sometimes observed in paralysis of certain muscles of the eye.

In crossed hemiopia the right side of the field is abolished in one eye, the left in the other. To thoroughly understand these two varieties, it is necessary to bear in mind how each half of the retina is supplied, as the

Fig. 14.

result of the crossing of the optic nerves in the chiasma. This crossing is not complete, and affects only the inner fibres of the nerves, which alone pass to the opposite side (Fig. 14).

This diagram shows us:—1. That the left optic nerve furnishes the external half of the left retina, and the internal half of the right

retina; injury to this nerve would thus produce right homonymous hemiopia.

2. The internal halves of each retina are supplied by the internal fibres of the two nerves. Any alterations limited to these fibres would produce a crossed hemiopia; the right eye would have the right half of its field obscured, the left eye the left half of its field.

3. The external halves of each retina are supplied by the external halves of each optic nerve. Alteration in these fibres would produce a crossed hemiopia, in which the left half of the field would be absent in the right eye, the right half in the left eye. These are the last examples of hemiopia, and are extremely rare.

Causes.—Homonymous hemiopia may be the result of the gradual compression by an intra-cranial tumour of one of the optic tracts; or it may be due to circulatory troubles, such as embolism, or spasm of the vessels, occurring in one of the optic tracts, or its place of origin. It is for this reason it may, in certain cases,

constitute only a transitory phenomenon, and subsist for a long time without producing any decoloration of the papilla, which derives its vascular supply from much nearer sources.

But how shall we explain crossed hemiopia? When the internal half of both retinæ have lost their sensitiveness we should expect some change at the point of decussation of the internal fibres at the chiasma, or in the posterior tubercular quadrigemina from which these fibres arise.

When it is a question of the external halves of the retina being paralysed, the lesion must be seated in the anterior tubercular quadrigemina.

This explication is applicable to persistent crossed hemiopia, but if it is transitory it can only be explained on the hypothesis upon some symmetrical disturbance in the arteries of the brain.

Method of Recognizing Hemiopia.— Hemiopia is recognized by the attitude of the patient, and by the exploration of the visual field. The healthy is usually separated

from the affected side by a line which, instead of being perfectly vertical, is somewhat oblique.

As for central vision, it is rarely affected, and patients can usually read the smallest characters; they generally find considerable difficulty in going about and looking round them, especially if the hemiopia is crossed.

3. **Scotoma** (Punctum Cæcum).—Scotomata are little gaps in the middle of the visual field, which, in most cases, depend upon lesions appreciable with the ophthalmoscope. They pass ordinarily unperceived when they are situated peripherically, but interfere considerably with vision when they are central. The patient complains of having continually before the sight a black patch, the shape of which he can sketch. This patch may conceal half the word he is looking at. This, however, does not constitute hemiopia, which we have described above.

Every one knows that there exists in each eye a physiological scotoma, that is the blind spot of Mariotte, corresponding to the papilla.

To make this evident, it suffices to make two little black dots on a piece of paper, with an interval of about six centimetres, and on the same horizontal line. Shut the left eye, and with the right fix your attention on the dot on the left-hand side. At first two dots are seen; but now gradually bring nearer to the eye the piece of paper, taking care not to take the sight off the left hand dot: at a certain distance the right hand dot will disappear, coming, however, again into view if the paper is brought still nearer. This disappearance takes place at the moment when the image falls upon the region of the papilla.

4. **Entoptic Images.**—This name is given to certain shadows which appear in the field of vision, and which are due to bodies either in the interior of the eye or upon its surface.

We distinguish the **muco-lachrymal** spectrum. The humours which cover the cornea—tears, mucus, etc.—produce sometimes in the field of vision shadows and illuminated circular spectra, which disappear and undergo constant

change by the movement of the lids. These are called the muco-lachrymal spectra.

Beaded Globular Spectra and Muscæ Volitantes.—The beaded spectrum is composed of a number of little globules, sometimes strung together like a pearl necklace. The aqueous spectrum is a clear band, bordered with a dark margin; the globular spectrum shows little isolated circles, ordinarily clear in the centre, but darker at the margins.

These are the spectra which give rise to what are called muscæ volitantes—the tears of so many patients, who really are free from serious disease. By many these muscæ are looked upon as physiological. Almost any one may be cognizant of them by looking fixedly at the blue sky, a white sheet of paper, or any bright white surface. They are most easily perceived if we look through a pin hole pierced in a card. Under these conditions, if the eye makes a movement from below upwards, these little bodies at first follow the movement, then gradually fall before the field of vision. Their mobility is

much greater in a horizontal than in a vertical sense.

These muscæ in no way interfere with distinct vision, and disappear by artificial illumination.

Causes.—They are due to little corpuscles, invisible with the ophthalmoscope, which float in the vitreous body, and which are generally found close to the retina. They are chiefly seen when the eye is fatigued by hard work, by microscopic and other minute researches.

Vascular Spectrum of Purkinge. — The possibility of seeing the vessels of one's own retina is one of the most curious of all entoptic phenomena. In order to do this, Listing suggests that with a strong lens a pencil of light should be directed upon the sclerotic whilst the eye is turned inwards as far as possible. The eye should be directed upon some dark medium, upon which will soon appear a drawing forcibly reminding us of the retinal vessels. We can obtain the same result according to Purkinge's method,

which consists of looking at a dark ground work, whilst the light of a wax taper is made to pass rapidly before the eye.

This phenomenon is due to the fact that the retinal vessels are situated in the retina in front of the nervous sensitive elements of this membrane (layer of rods and cones), and can consequently be made apparent under certain conditions.

ARTICLE III.

PHOSPHENES.

The mechanical compression of the retina does not give rise to pain, but to luminous sensations, to which the name of phosphenes has been given. From this the popular expression of seeing a thousand candles when a blow is received upon the eye. To produce them under the most favourable conditions the patient should be in a darkened room, the eyes should be gently closed and turned in a direction opposite to the spot where the compression is to take place, and

in this way pressure is brought to bear upon the deeper and more sensitive parts of the retina. We now compress the globe either with the nail or some small hard body, and immediately the patient observes a luminous sensation of a whitish-blue colour, forming a circle, or half circle, and situated at a point diametrically opposed to that in which the compression has been made. If, for instance, the pressure has been made upwards, the spectrum will appear below.

This is due to the following physiological law. Whenever the retina receives an impression, it projects it externally in the direction of a line perpendicular to the point impressed, and passing through the optical centre of the eye. It is in virtue of this law that we see things in their natural position when their images are reversed upon our retinæ.

Sometimes a similar luminous spectrum, or phosphene, appears at the same spot where the compression is made: it results from compression by *contrecoup*, exercised by the vitreous body upon the opposite part of the

retina. We can obtain information concerning these phosphenes by compressing any part of the retina; in practice we content ourselves by testing it in four cardinal points, viz., above, below, outwards, and inwards. The four spectra thus obtained are called respectively the frontal, the jugul, the temporal, and the nasal spectrum.

These phosphenes merely indicate the sensitiveness of the retina to pressure, but its sensitiveness to light generally goes hand in hand with this, and for these reasons they are of some functional importance.

ARTICLE IV.

SENSITIVENESS OF THE RETINA TO DIFFERENT COLOURS—DALTONISM.

The retina enjoys the faculty of being able to appreciate different colours, together with their most delicate shades. When this faculty is lost or perverted, we have the condition known as Daltonism—from Dalton, who first

described these phenomena. It is rare that all perception of colour is abolished; usually the retina is insensible only to certain colours or certain shades. Daltonism is either congenital or acquired. It is found as a congenital affection in about 5 per cent. of all individuals. Some cannot distinguish red, others confuse blue and violet, yellow and green. It is owing to this anomaly that some painters can never give to their pictures the proper harmony of tones and of colours.

Acquired Daltonism may be produced temporarily by the administration internally of santonine, which makes everything appear of a greenish-yellow. In jaundice, too, sometimes everything appears yellow to the sufferer, but it is affections of the retina and optic nerve which produce it most often. M. Galezowski has shown the importance of this symptom as a help to diagnosis. In order to test for this condition we must have a scale of different colours in paper, wool, or other materials to lay before the patient.

Holmgren's system, with the coloured wools, is the one most usually employed in this

country. It is based upon the Young-Helmholtz theory, that red, green, and violet are the primary or fundamental colours, the remainder being combinations of these in various proportions. Holmgren has these test skeins and a large number of other skeins, variously coloured, which have to be assorted by the patient.

TEST I. is a *pale green;* TEST II. is *purple*, and TEST III. is a *bright red.*

TEST I. (*pale green*) is given to the patient. If with this test he assorts drabs and greys he is *colour blind*, and TEST II. (*purple*) is given to him. If with TEST II. he assorts blue or violet shades he is *red blind;* if, on the contrary, he assorts greens or greys, he is *green blind.* If he assorts other purple shades with TEST II. he is only *incompletely* colour blind.

TEST III. (*bright red*) is a supplemental test.

The *red blind* put dark greens and browns with it.

The *green blind* put lighter greens and browns with it.

The *violet blind* put red, orange, and purple together with it.*

ARTICLE V.

HEMERALOPIA—NYCTALOPIA.

CERTAIN persons see perfectly during the day, and at night can hardly find their way about, so defective is their vision. This condition is known by the name of hemeralopia.

The affection depends upon a kind of anæsthesia of the retina, which can only execute its functions when the light is very intense. Sometimes it is transitory, and affects, in an epidemic form, barracks, convents, and other places where persons are congregated together. In these cases spasmodic contractions of the retinal arteries can sometimes be

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* The necessary assortment of wools for testing colour perception can be had from Messrs. Horne & Thornthwaite, Strand, London. And for further particulars consult "Colour Blindness," by Dr. Joy Jeffreys (Houghton, Osgood, & Co., Boston, 1879); "De la cécité des Couleurs," Paris, 1877; translation of Holmgren's book.

made out. Sometimes it is persistent, and as such constitutes one of the most characteristic symptoms of retinitis pigmentosa.

Nyctalopia is the opposite condition. The patient sees better at night or in twilight. This condition is found in all conditions characterised by photophobia, in atrophy of the papilla, and the toxic forms of amblyopia.

CHAPTER II.

DIAGNOSIS OF VISUAL DISTURBANCE—CLINICAL METHOD.

The diagnosis of disturbances of vision constitutes in reality a very complex problem, the solution of which necessitates a certain method.

When a patient presents himself, complaining of some alteration in his visual powers, the first thing to do is to ascertain with each eye separately the finest letters of the scale he is able to decipher.

If he cannot read the largest figures, he may yet be able to count fingers. In still more pronounced cases the hand may be passed before the eye to ascertain if its shadow is perceived, and if he can distinguish night from day.

When amblyopia has been ascertained, and its degree defined by means of the

types, we must bear in mind that all visual disturbance may be attributed—

(1) To defects in the transparency of the refracting media;

(2) To anomalies of refraction and accommodation;

(3) To paralysis or muscular spasm producing diplopia;

(4) To alterations of the deeper structures, of the optic nerve or brain.

To which of these classes does the case under investigation belong? This we must endeavour to determine according to the following considerations:—

1. **Defects of Transparency.** — These are best recognized, if they escape the naked eye, by oblique illumination when they are seated in the cornea or lens. The mirror at once detects those which are situated in the vitreous chamber.

2. **Anomalies of Refraction and Accommodation.**—The first are usually congenital and exist in both eyes, are improved by

looking through a pin hole, and corrected by suitable glasses. Anomalies of accommodation are suggested by advanced age (presbyopia), or by mydriasis or myosis which usually coexist with paralysis or spasm of the accommodation. These are also improved by looking through a pin hole, and corrected by appropriate glasses.

3. Paralysis or Spasm of the Muscles. — Often a squint is apparent. There is always diplopia when the patient looks in a certain direction, and which ceases as soon as he closes one eye. Here vision in each eye separately is good; binocular vision alone is defective.

4. Alteration of the Deeper Structures, of the Optic Nerve or of the Brain.— All visual disturbances which do not come within one of the previous groups necessarily belong to this one. And it is by a process of elimination that we establish our diagnosis. We must then confirm it by means of functional symptoms and an ophthalmoscopic examination.

Value of Functional Symptoms. — They are of the greatest importance, and often permit of a diagnosis being established which it only remains for the ophthalmoscope to confirm. This is especially the case, as we shall see, in the following groups of cases:—

1. Progressive atrophy of the papilla.
2. Certain forms of neuritis from cerebral causes.
3. Embolism of the central artery.
4. Retinitis pigmentosa.
5. Affections of the macula.
6. Detachment of the retina.
7. Apoplexies of the vitreous body.
8. Amblyopia from toxic causes.

To draw from these functional symptoms all the valuable information they are capable of imparting, we must examine with care both the central and peripheral vision, phosphenes, etc. We must equally ascertain if the affection has its seat in one or both of the eyes; if loss of vision has been sudden or slow.

In point of fact, monocular amblyopia is

compatible with some affections, incompatible with others. The same remarks apply to the sudden or slow advent of blindness. We point out a few examples, as illustrating these remarks:—

Monocular affections.

1. Embolism of central artery.
2. Apoplexy of macula.
3. Detachment of retina.
4. Apoplexy of vitreous body.

Binocular affections.

1. Progressive atrophy.
2. Neuritis from cerebral causes.
3. Retinitis pigmentosa.
4. Retinitis albuminurica.

Diseases of rapid invasion.

1. All the monocular affections above noted.
2. All affections of the macula in general.
3. Certain forms of neuritis of cerebral origin.

Diseases of slow invasion.

1. Atrophy of the papilla.
2. Retinitis in general.
3. Choroiditis in general.

Certain functional symptoms are of themselves almost pathognomonic. Thus, the loss of the upper part of the visual field in a myopic patient almost always indicates detachment of the retina. Concentric contraction, with preservation of central vision, almost always indicates retinitis pigmentosa, or incipient glaucoma.

But it is chiefly according to the manner

these symptoms are combined, or are excluded, that we arrive at a precise diagnosis. Thus we shall see further on (Embolism) how the analysis of certain functional symptoms are alone sufficient to separate from each other the different affections which are characterized by the sudden loss of sight in one eye.

Let us add that these symptoms frequently prevent us from being led away by a diagnosis made by the ophthalmoscope alone in the hands of inexperienced persons. Thus, conservation of central vision would prevent us mistaking a physiological paleness of the papilla for commencing atrophy, opaque nerve fibres for exudation, hyperæmia in the region of the macula for extravasation.

Value of Ophthalmoscopic Symptoms.—There is no need here to insist upon the importance of these symptoms. It is they which give to our diagnosis the impress of certainty, and which establish the distinction between structural changes in the membranes and the other forms of amaurosis, properly so called.

To study them methodically, we should always recommend the use, at first, of oblique illumination, which gives us information concerning the transparency of the media. Next, the eye is illuminated with the mirror alone, and thus the refraction ascertained. Next, the inverted image is examined, and finally, if necessary, the erect image for the investigation of minute changes in the deeper structures of the eye.

PART III.

OF THE AFFECTIONS OF THE DEEPER STRUCTURES OF THE EYE.

The subjects of these chapters will comprise:

1. Affections of the optic nerve.

2. Affections of the retina.

3. Affections of the choroid.

4. Affections of the vitreous body.

5. The different forms of amblyopia and amaurosis, properly so called.

6. The ophthalmoscopic diagnosis of the different errors of refraction.

CHAPTER I.

OPTIC NERVE AND RETINA.

ARTICLE I.

OPTIC NERVE.

Ophthalmoscopic Appearance. — The papilla is the intraocular extremity of the optic nerve, of which, in a way, it represents a transverse section. It has the form of a round disc, or of an oval with its principal axis vertical. Its pinkish-white colour contrasts strongly with the deep red of the fundus, and in its centre is the point of emergence of the retinal vessels. The papilla is situated from three and a half to four millimetres to the inner side of the antero-posterior axis of the eye, and about one millimetre below this spot.

The papilla is of a faint rose colour, but varies considerably in different individuals.

The colour is not uniform over its whole surface. Thus, the central part is quite white, on account of a slight physiological depression which exists at its apex; the inner half, seen in the inverted image, seems a little whiter than the outer half, on account of the unequal distribution of the capillary vessels. It is important to bear this in mind, otherwise the whiteness might be mistaken for the commencement of an atrophic process. Its contour is well defined, sometimes surrounded by a slight pigmented margin; sometimes, on the contrary, it is surrounded by a white rim, due to the fact that the choroidal aperture is larger than the sclerotic aperture, and allows the white reflection of the latter to be seen round the nerve.

The real diameter of the papilla is about two millimetres. Its apparent size depends—(1) on the strength of the lens we are using; (2) on the condition of refraction of the eye under observation; (3) whether the examination is taking place by the inverted or direct method.

1. The stronger the lens being used, the

greater its power of concentrating the luminous rays into a small space, consequently, the smaller the image.

2. We pointed out previously, that of all papillæ, that of the myopic eye is the smaller, and that of the hypermetropic eye the larger.

3. With the inverted image the papilla appears four or five times as large as reality. The erect image gives a magnifying power of about fourteen diameters.

The nutritive vessels of the papilla, or those to which its coloration are due, are capillary vessels. They mostly come from the arteries of the brain through the medium of the sheath of the optic nerve. Others are furnished by the posterior ciliary vessels (Leber), and a few, perhaps, from the central vessels (Sappy).

The larger vessels, which emerge from the centre of the papilla, are destined to supply the retina. They are called the central artery and veins.

The central artery arises from the ophthalmic. Arrived at the papilla it separates into

two branches, one superior, the other inferior. When these branches have attained the margin of the disc they re-divide and subsequently become frequently subdivided, but they never undergo anastomosis, either with themselves or with the vessels of the choroid. The central vein subdivides in the interior of the optic nerve itself, so that it appears upon the papilla in the form of several branches, subdividing after the manner of the arteries.

Difference between these Vessels and those of the Choroid.—The distinction is easily made. The retinal vessels emerge from the papilla, stand out in relief, and have a brilliant red colour, present regular branching ramifications, and have a double contour. This phenomenon is due to the fact that light more easily traverses the centre of the vessels and makes the margins appear darker by contrast.

The choroidal vessels are not always apparent. They present a more flattened outline of a reddish tint. They intersect each other in different directions and very

irregularly, and show no appearance of a double border.

Differences between the Arteries and Veins—Pulsations.—The arteries are smaller, more superficial, and less tortuous than the veins in front of which they often pass; their colour, too, is not so deep, and they exhibit more frequently the phenomenon of the double border. Their spontaneous pulsation is always due to pathological causes.

The veins are larger, deeper in colour, and more tortuous. They rarely show the double border. Pulsation in them is a physiological phenomenon.

These pulsations are very remarkable circumstances. The venous pulse comes after the radial pulse; it is not continuous. It frequently is seen in persons whose circulation has been accelerated by walking. Slight pressure upon the globe with the finger easily provokes it. When it exists it is only appreciable upon the papilla, as the seat of emergence of the large vessels. This is the explanation of it:—

When the heart contracts, the arterial vessels of the eye receive a greater quantity of blood. This exercises a certain amount of compression upon the vitreous body, which, in its turn, presses upon the large veins, and renders them smaller. No sooner does the cardiac systole cease than the vessels dilate and regain their normal size.

As for arterial pulsation, it can be produced by considerable pressure with the finger, but when it occurs spontaneously it is always a pathological phenomenon and depends upon increased intraocular pressure (glaucoma). Under the influence of this pressure, the calibre of the artery diminishes and may become completely abolished, but the wave of blood thrown up by the cardiac systole, separating its compressed walls, opens for a moment again the channel of the artery, to be extinguished on the cessation of the systolic contraction.

These pulsations are also visible only on the surface of the papilla.

Physiological Excavation of the

Papilla.—We have just described the normal papilla. The variety we shall now describe departs more or less from the classical type, but is nevertheless a physiological condition.

We know that every papilla presents a little central depression at the point of emergence of the large vessels. In certain cases this depression is sufficiently considerable to occupy the quarter or even the half of the disc. This is called a physiological excavation.

This excavation presents the following characteristics:—

1. All the excavated portion is white.

2. At its apex all the vessels seem more deeply situated than upon the rest of the disc, and we notice the bend they make in leaving the excavation. Should the walls of the latter be very perpendicular, we see the vessels assume the form of a hook on passing over its border.

3. The rest of the papilla retains its normal colouring.

4. Vision remains perfect.

We will point out further on (Glaucomatous Excavation) how this physiological

excavation is distinguished from all kinds of pathological excavations.

ARTICLE II.

RETINA.

Ophthalmoscopic Appearance. — The retina is invisible, so perfect is its transparency; we only see its vessels.

Nevertheless, in certain deeply-pigmented eyes, it reflects a certain amount of light, and presents in the neighbourhood of the papilla, where it attains its maximum of thickness, a greyish streaked appearance, which must not be mistaken for a pathological condition.

Opaque Nerve-Fibres. — Another form of opacity of the retina, also physiological, is constituted by the presence of congenital opaque nerve-fibres. These are white patches, often of considerable extent, situated generally on the external side of the papilla when seen in the inverted image, but, nevertheless,

sometimes completely surrounding it. These are their chief characteristics:—1. They have a distinctly striated appearance. 2. Their margin is very irregular, and surrounded by healthy retina. 3. They trench upon the papilla itself very often. 4. They mask the retinal vessels. 5. They in no way influence vision. They very closely simulate exudations into the retina, with which it is important they should not be confounded (*see* Exudative Retinitis).

Nature of the Fibres. — In the optic nerve, the fibres are surrounded by a neurilemma, of which they are deprived on arriving at the lamina cribrosa. In certain cases, however, they preserve this envelope, which is opaque. It is a very common condition amongst animals, such as rabbits, and it is this condition which constitutes the physiological peculiarity we pointed out above.

Macula.—The macula, or yellow spot, is the central part of the retina. This region has the form of an oval, with its major axis

horizontal, and measuring about two millimetres. It is situated about four millimetres to the outer side of the centre of the papilla, according to Wecker.

Its aspect varies; often it is indistinguishable from the rest of the retina. Sometimes it appears in the form of a little spot, somewhat redder than the rest of the fundus. In some cases, especially children, it appears to be surrounded by a whitish glistening oval ring. This is, however, due to an optical illusion.

The region of the macula can be explored either in the erect or the inverted image.

In the erect image, the patient should look straight in front at the hole in the mirror of the ophthalmoscope.

In the inverted image, we should first seek the papilla as a guiding point. The macula is found on a line tangent to the upper margin of the papilla, to its inner side, and separated from it by a distance equal to about twice its diameter.

CHAPTER II.

AFFECTIONS OF THE OPTIC NERVE.

We must here study—

1. Congestion of the papilla.
2. Atrophy of the papilla.
3. Pathological excavation.
4. Optic neuritis and neuro-retinitis.
5. Embolism of the central artery.
6. Tumours of the optic nerve.

ARTICLE I.

CONGESTION OF THE PAPILLA.

As a distinct and separate disease, congestion of the papilla has been denied by many ophthalmologists, and, in point of fact, what we often are inclined to set down as a condition of hyperæmia is only a variety of a physiological condition.

But symptomatic congestion of the papilla is of frequent occurrence. It is found in certain congestive conditions of the brain, as well as in cases of retinitis and choroiditis. Here, however, it only constitutes a secondary symptom, to be found in many of the affections of the deeper structures of the eye.

ARTICLE II.

ATROPHY OF THE PAPILLA.

An atrophied papilla is a papilla which has lost its functional properties, and which has become completely white, owing to the disappearance of its capillary vessels.

Varieties. — Atrophy of the papilla is symptomatic of the most diverse affections: so many different causes; so many varieties of atrophy, having special characteristics. We may thus distinguish:—

I. Progressive atrophy.
II. Atrophy consecutive on neuritis.

III. Following embolism of central artery.
IV. Consecutive to retinitis pigmentosa.
V. Glaucomatous atrophy.

I.—Progressive Atrophy.

It is the most common form, and presents all the most classic symptoms of the affection.

Functional Symptoms.—None of these are pathognomonic, but, taking them altogether, they are sufficiently characteristic to enable us to establish a probable diagnosis.

1. *Commencement.* — Slow, insidious, first assumed by a kind of mist which surrounds objects.

2. *Central Vision considerably Covered.* — From the first few months the patient can no longer read large letters, and the sight gradually fails, until the blindness is complete.

3. *Peripheral Vision.* — Intact at first, but in course of time becomes restricted, owing to an irregular concentric contraction.

4. *Nyctalopia.*—The patient sees better in the evening than in broad daylight, when the strong light dazzles him.

5. *Daltonism.* — He distinguishes colours badly, unless, perhaps, it be yellow and blue, the recognition of which persists for some time.

6. *Photopsia and Chromopsia.*—These are uncommon, and the recognition of phosphenes is soon lost.

7. The malady is steadily progressive.

8. The affection is almost always binocular. The two eyes are usually affected at short intervals, but to an unequal degree, one usually being worse than the other.

9. *Myosis.* — The pupil is generally much contracted, if the cause of the disease is spinal; usually somewhat dilated in other cases. It reacts less and less under the influence of light, but this is not a constant symptom.

10. *General Symptoms.* — We often find symptoms of a spinal or cerebral affection, of which the atrophy is usually symptomatic. Thus there may be flying pains, loss of

sensation in the part, diplopia, vertigo, cephalalgia, loss of memory, etc.

Ophthalmoscopic Symptoms.—1. *Decoloration.* — The white aspect of the papilla is the most pathognomonic symptom. An atrophied papilla preserves its shape and the same size as in a physiological condition, but it loses its delicate rose tint to assume a white, pearly, or sometimes a bluish-white tint.

2. *Loss of Transparency.* — At the same time it becomes opaque, and we no longer see part of the intra-nervous course of the retinal vessels.

3. *Condition of the Larger Vessels.* — These coming from the ophthalmic, and being specially destined for the retina, maintain, for a long time, their normal volume. The true nutritive vessels of the papilla being capillary vessels, which come chiefly from the cerebral arteries by means of the sheath of the nerve, become first atrophied and produce the characteristic white appearance.

4. *Atrophic Excavation.* — The tissue of an atrophied papilla having become less

resisting, gives way somewhat under the intraocular pressure; in this way the disc becomes somewhat excavated, as may be seen by the course imparted to the vessels at the margin of the sclerotic ring, but this is often scarcely appreciable.

Pathological Anatomy.—The alteration of the optic nerve presents itself in the form of grey induration, commencing ordinarily in the papilla and spreading gradually to the optic tracts and to the corpora geniculata. Histologically, the change consists in a fibrous metamorphosis of the neuroglia, and a gradual disappearance of the myeline and the axis cylinder of the nerve-fibres.

Causes. — These are: 1. *Spinal.* — Progressive locomotor ataxy is one of the most frequent causes. What relation exists between these two affections? Modern researches have demonstrated that grey degeneration is an alteration which has a tendency to show itself in multiple foci, having no connection with each other. It attacks the optic nerves at the

same time, and for the same reason, as the spinal cord and the encephalon; and sometimes even many years before the nervous centres are themselves attacked (Charcot). It has been tried to show that there are special symptoms characteristic of this form of atrophy, which would differentiate it from other forms. It has been remarked—(1) That the papilla has a peculiar bluish tint; (2) that the calibre of the larger vessels is retained; (3) the absence of atrophic excavation, because cellular tissue is here substituted for nerve-tissue, whilst in other varieties, the nerve-tissue simply disappears. The condition of myosis and the presence of flying pains constitute better symptoms, and are more easily recognized.

2. *Cerebral.*—Let us specially point out atheromatous degeneration of the vessels of the brain, and all the chronic affections of the optic tracts and tubercula quadrigemina (selerosis, softening). Cerebral tumours more frequently give rise to optic neuritis than progressive atrophy.

3. *Constitutional.*—Here we have to do with

certain alterations of the blood — such as syphilis, glycosuria, and the effects of miasma, alcohol, and tobacco.

It is impossible to assign definite characteristics to these different varieties. It is by questioning with care into the general state, and by a method of exclusion, that we shall arrive at the cause in any one case. We should, in all cases, advise an examination of the urine to be made. Syphilitic atrophy is very rapid in its progress ; alcoholic atrophy is extremely rare.

4. *Orbital Causes.*—Tumours of the orbit (exostoses, cysts, carcinoma) may determine an atrophy by compression of the nerve. This form of atrophy is monocular, accompanied by exophthalmos, and often with paralysis of certain muscles of the eye.

5. *Ocular.*—Atrophy of the papilla may follow an attack of choroiditis ; it is then characterized by a diminution of the central vessels in an inverse proportion to what generally takes place in the spinal form.

6. *Traumatic Causes.*—Blows and falls on the head are a sufficiently frequent cause of

atrophy, either in its monocular or binocular form.

7. *Reflex Causes.*—The influence of certain chronic affections of the gastro-intestinal mucous membrane, in the form of intractable diarrhœa and other affections, have also been pointed out.

II.—Atrophy Consecutive upon Optic Neuritis.

Functional Symptoms.—These are the same as in progressive atrophy, the only difference being—

1. By the way in which it commences, which is by neuritis. It may be rapid or it may be slow in its course.

2. By the stationary nature of the atrophy, which once declared may nevertheless stop short in its course, if the disease which gave rise to it itself becomes cured.

Ophthalmoscopic Symptoms. — These are characteristic, but they sometimes require delicate powers of observation.

1. The papilla is white, but often a dirty

kind of white. It is a little prominent and opaque, the lamina cribrosa being scarcely visible on the point of emergence of the central vessels.

2. The margin of the papilla is not deformed as in the preceding variety; it is slightly clouded on account of the traces of inflammation persisting for a long time.

3. The veins of the retina remain enlarged and tortuous.

4. Occasionally traces of exudation, which have not yet disappeared, are seen in the course of the large vessels.

5. In the neighbourhood of the papilla, the choroid sometimes shows little patches of atrophy, due to compression of its tissue, during the existence of the neuritis. It is a good sign when it exists, for it at once attracts our attention.

III.—Atrophy Consecutive upon Embolism of the Central Artery.

Functional Symptoms.—These are of the greatest importance.

1. The onset is sudden; the eye affected is struck with immediate blindness, which, for the most part, is irremediable.

2. The affection is always limited to one eye alone.

Ophthalmoscopic Symptoms.—White pearly appearance of the papilla two or three months only after the attack. Wasting of the large vessels. Margin of the papilla slightly clouded; often the aspect is exactly the same as in progressive atrophy, and the diagnosis can only be made by the history of the case, and the localization of the atrophy in one eye only.

IV.—Atrophy Consecutive upon Retinitis Pigmentosa.

Functional Symptoms. — They differ from those of progressive atrophy under two headings.

1. Peripheral vision is here lost before central vision, to such an extent that often

the patient can still read when he is unable to go about the streets.

2. Hemeralopia takes the places of nyctalopia and constitutes one of the first symptoms of the affection.

Ophthalmoscopic Symptoms.—1. The papilla is white.

2. The central vessels are always considerably diminished in size, and often reduced to mere threads.

3. Black patches of pigment are seen along the course of the larger vessels, chiefly in the region of the ora serrata.

V.—Glaucomatous Atrophy.

Functional Symptoms.—The commencement is often preceded by paroxysms of acute glaucoma. At other times it is slow and insidious.

2. Central vision gradually fails, but as a rule lasts longer than peripheral vision.

3. Peripheral vision commences to fail

almost always on the inner side; subsequently, however, the contraction becomes concentric.

Ophthalmoscopic Symptoms.—1. The papilla is white and excavated in its whole extent. 2. The large vessels have the characteristic bend where they emerge from the disc. 3. The latter is often surrounded by a small white circle, due to a limited atrophy of the choroid. 4. The central artery is often the seat of spontaneous pulsations.

Diagnosis.—We must first recognize the existence of atrophy; then distinguish its variety.

The existence of atrophy is put beyond all doubt by the presence of the group of functional symptoms described previously, and above all by the white aspect of the papilla, which is characteristic of all the different kinds of atrophy.

Toxic Amblyopia.—At the commencement, when the whiteness of the papilla is as yet incomplete, or doubtful, progressive

atrophy might be confounded with toxic amblyopia, for the functional symptoms much resemble each other in these cases, and there is scarcely any appreciable ophthalmoscopic lesion. We should base our diagnosis upon the following differences:—

In toxic amblyopia the onset is generally rapid, and the patient is soon unable to read Nos. 10 or 15 of the scale. The case then remains stationary, or is subject to slight variations. Colour blindness exists, and is noticeable especially with brilliant objects. Gold coins cannot be distinguished from silver. Both eyes are affected as in progressive atrophy, but always in the *same degree* (this is a valuable sign). There are general signs of alcoholism—trembling of the limbs, nightmare, hallucinations.

Physiologically Pale Papilla.—It is possible to mistake for an atrophied papilla, one that is somewhat whiter than usual, or one that is surrounded by a posterior staphyloma not recognized, and the white colouring of which is mistaken for the papilla. It will

be sufficient to question the patient upon his visual functions to escape this error.

Varieties of Atrophy.—The table on pages 122, 123, in which we have given a *résumé* of the chief signs of the different kinds of atrophy, will allow us rapidly to arrive at a diagnosis.

Prognosis.—Progressive atrophy of the papilla is a very grave disease, as also is that which is due to retinitis pigmentosa.

Atrophy consecutive upon a neuritis may remain stationary. That due to glaucoma may be cut short by an iridectomy. Atrophy due to embolism, being a monocular affection, is of less gravity than the other forms.

Treatment.—(1) *Local:* Revulsions; applying blisters to the nucha; friction of the temples with phosphorized oils and ointment of strychnine.

(2) *General:* In atrophy connected with locomotor ataxy, nitrate of silver in pills, iodide and bromide of potassium, and arsenical

preparations are of use. Hydropathy, electricity, sulphur baths, and the application of the cautery to the spine may also prove beneficial.

Mercurial treatment is indicated if the history is syphilitic, and a tonic treatment if there is general debility.

The use of emetics has been attended with success in cases where the disease seemed to depend on some affection of the gastro-intestinal mucous membrane.

ARTICLE III.

GLAUCOMATOUS EXCAVATION OF THE PAPILLA.

When intraocular pressure is increased, and is exercised slowly and for a length of time, the papilla, which is the least resisting part of the eye, becomes dimmed and pushed back until it assumes the same level as the sclerotic, or even passes beyond it. We then say there is glaucomatous excavation of the papilla.

Functional Symptoms.—1. *Onset:* The excavation follows successive attacks of acute glaucoma, or it is more gradually and insidiously brought about in the chronic form.

2. *Central Vision.*—This is generally lost coincidently with contraction of the field. In some severe cases it seems to survive the latter, and we occasionally find patients capable of reading small print who, nevertheless, cannot find their way about, so restricted has their field of vision become.

3. *Peripheral Vision.*—From the first commencement of the affection, the visual field begins to be contracted on the inner side, so that the patient sees less on the nasal than on the temporal side. This depends upon the fact that it is the external part of the papilla which becomes first atrophied. The larger vessels, being on the inner side, protect this somewhat from the effects of compression.

Later on, the contraction affects the upper and lower parts of the field, and finally the whole is invaded.

4. *Photopsiæ.* — These are frequent, and provoked by compression of the retina.

5. *Increased Intraocular Tension.*—This is discovered by palpation of the eye, which sometimes feels as hard as a marble. Special instruments have been constructed to measure this degree of hardness.

6. The affection is usually binocular.

Ophthalmoscopic Symptoms.—1. The papilla is white and atrophied in consequence of the compression to which it has been subjected, and the lamina cribrosa becomes very distinctly visible.

2. The excavation always occupies the whole surface of the disc; its borders are pointed.

3. All round the margin of the disc the vessels appear to be cut suddenly short, or interrupted in their course, as they bend round the edge of the disc in a way which is very characteristic (Fig. 15).

It is easy to understand how this happens. Let A B and A B′ be branches of the central artery. These are easily seen at the bottom of the excavation, which they line, but when they mount the lateral walls they disappear

in the direction of B C and B′ C′, to reappear again as they round the margin of the disc.

As for the vein, as it divides before the artery, its branches are pushed back by the vitreous plug which fills the excavation, and they do

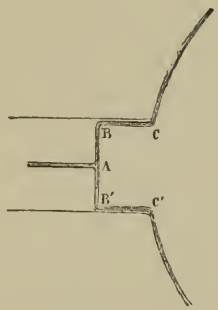

Fig. 15.

not become visible until they reach the periphery of the papilla.

4. The compression exercised upon the vessels causes the arteries to appear smaller and the veins larger. The vessels altogether become so displaced and driven into the papilla, that in the inverted image the internal half of

the excavation seems to be entirely deprived of vessels.

5. By imparting slight movements to the lens, we notice that the vessels situated on the border of the papilla seem to become displaced much more than those at the bottom of the excavation. This parallactic displacement is the more marked in proportion to the different depths of the excavation.

6. The papilla seems frequently to be surrounded by a white ring of varying size, due to atrophy of the choroid, produced by an excess of intraocular pressure.

7. Spontaneous pulsation is frequently seen in the central artery; in all cases the least pressure produces it. This sign is pathognomonic.

We shall find it difficult to mistake glaucomatous excavation for physiological excavation. The latter is always partial, never extends over the whole surface of the papilla, so that a portion of the latter, in the form of a ring, always retains its rosy aspect. If the vessels hook round the margin of the disc, which is usually a rare condition, this

bending does not take place at the margin of the papilla, but always at some distance from it.

If we divide the papilla into two halves by an imaginary perpendicular line, we shall see that both halves contain vessels. There is never spontaneous arterial pulsation; the condition never produces visual disturbance.

Atrophic excavation is scarcely appreciable, and the vessels never hook round the margin of the disc, but are merely slightly curved on passing over its margin.

In a case of atrophy occurring in a papilla presenting the signs of physiological cupping, the difficulty of diagnosis may be considerable; the presence or absence of arterial pulsation will greatly help the diagnosis.

The treatment is naturally the same as for glaucoma.

ARTICLE IV.

OPTIC NEURITIS AND NEURO-RETINITIS.

Optic neuritis is inflammation of the papilla. When the inflammation extends beyond this on

to the neighbouring retina, for a distance equal to two or three times the diameter of the papilla, it is called neuro-retinitis, or peri-neuritis.

Functional Symptoms.—They can only serve to establish a probable diagnosis in very well-marked cases.

1. *Onset.*—This is generally very rapid if the cause is cerebral or situated in the neighbourhood of the nerves or optic tracts. In other cases it is slower and more insidious.

2. *Central Vision* may be abolished in a few hours or a few days. On the other hand, it may only be lowered in a variable degree, which is often by no means in proportion to the changes revealed by the ophthalmoscope. It depends chiefly upon the seat of the lesion as regards the macula, and of the degree of compression of the nervous elements of the retina.

3. Peripheral vision undergoes the same variations as central vision.

4. Photopsiæ are frequent, owing to compression of the retina.

5. *Pain.*—The patient experiences pain deep in the orbit on account of compression of the nerve-fibres in the sheath of the optic nerve.

6. *Affection always Binocular.*—This is an almost absolute rule when the cause is cerebral. In point of fact, the inflammation of one optic nerve must of necessity be communicated to the other when they cross at the chiasma.

7. *Mydriasis.*—It is very marked when the cause is cerebral; it is an opposite condition to the myosis of progressive spinal atrophy.

8. *Concomitant Cerebral Symptoms.*—These are cephalalgia, vomiting, convulsions, and different forms of paralysis.

Ophthalmoscopic Symptoms. — These are the only reliable signs of the malady. They almost all depend upon the augmentation in volume of the papilla, and to the kind of strangulation it is subjected to in the inextensible sclerotic ring which surrounds it.

1. *Increase in Volume of the Papilla.*—The papilla is swollen. Its tissue overflows the limits which should surround it, and spreads

itself over the retina. In this way its volume sometimes appears doubled or even tripled.

2. *Prominence of the Papilla.*—It projects into the interior of the eye, and being thus brought nearer to the lens than it should be, we get an erect image of it with the mirror alone, as in the case of hypermetropia.

3. *Indistinct Contour.*—Its contour, instead of being clear and distinct, becomes irregular and effaced by exudations, which are spread over the neighbouring retina in such a way that the papilla can sometimes only be recognized by the point of emergence of the great vessels.

4. *Change of Colouring.* — The papilla, although obscured, sometimes appears of an intense red, owing to exaggerated development of all its capillary vessels.

5. *Changes which the Larger Vessels undergo.* —The arteries become small and filiform, because the strangulation of the papilla does not allow arterial blood to pass in sufficient quantity. For the same reason the veins become engorged, varicose, and tortuous, because the returning circulation is seriously

interfered with. These large vessels are often obscured by exudations in such a way that certain portions of their course are hidden, and they appear as though they were cut in two, and divided into blocks or truncated pieces.

6. *Integrity of the Peripheral Parts.*—But for the dilatation of the veins the rest of the retina remains in a condition of perfect integrity.

7. *Atrophic Period.* — After a certain lapse of time arrives the period of repression, in which the inflammatory symptoms disappear to give place to those of atrophy of the papilla.

The symptoms we have just described reach their maximum development in cases of optic neuritis; they are less marked in neuro-retinitis or peri-neuritis. Visual disturbances are also less marked in these cases.

Causes.—These are: 1. *Cerebral.*—These are by far the most frequent. Observation has shown that the only cerebral affections which are capable of determining neuritis are—

(1) basilar meningitis, simple or tubercular; (2) encephalus; (3) different forms of cerebral tumour. It is by the general symptoms, and not by the ophthalmoscope, that the diagnosis of the cause can be made. And it is by means of paralysis of the different cranial nerves that we shall arrive at a knowledge of the seat of the lesion.

2. *Orbital.* — Any tumour seated in the orbit, or in the interior of the nerve itself (rare), may set up a neuritis. This is, of course, monocular, is accompanied by exophthalmos, and often with paralysis of the different muscles of the eye. When the tumour is situated in the nerve, the compression of the central artery is such, that the blood arrives at the retina only during the systole of the heart; we then see arterial pulsation.

3. *Constitutional.*—We may here point out syphilis and albuminuria.

In albuminuria the changes extend, usually, so far beyond the papilla, that they are more frequently described under the heading of retinitis.

4. *Undetermined Causes.*—In some cases the causes are obscure. Sometimes it can be traced to disturbance of the uterine organs, to masturbation, to rheumatism, to miasmatic poisoning, or purulent infection.

Pathology.—To explain the mode of production of neuritis in cerebral affections several theories have been advanced.

1. *The Theory of Descending Neuritis.*—According to this theory, inflammation creeps down the optic tracts along the nerve, and finally arrives at the papilla. We can easily understand this in a case of meningitis; but less easily in cases of tumour situated at a distance from the expansion of the optic nerves, and without any trace of surrounding inflammation.

2. *Theory of Strangulation by Venous Stasis.*—De Graefe thought that when, as the result of intra-cranial pressure produced by the tumour, the circulation becomes impeded in the cavernous sinus, the impediment extends to the ophthalmic and central vein of the retina. This, in its turn, produces a

condition of œdema of the optic nerve, and as this is tightly grasped by the inextensible ring of the sclerotic, it becomes strangulated, and subsequently inflames. It is in these cases that the ophthalmoscopic symptoms are developed in their maximum degree, the swelling of the papilla sometimes being enormous.

3. *Theory of the Sub-vaginal Space.*—There exists between the two sheaths of the optic nerve a space called sub-vaginal, which communicates with the cavity of the arachnoid. An increase in the intra-cranial pressure may drive the arachnoid fluid between these sheaths, thence directly compressing the nerve and producing the results described above.

Amongst all these conflicting theories, that of the descending neuritis is best established, and certainly offers the most satisfactory explanation in a large number of cases.

Diagnosis.—The diagnosis of optic neuritis presents no difficulties, and neuro-retinitis is not easily mistaken for simple neuritis. In the former the lesions are limited to the

papilla and its neighbourhood for a space about equal to two or three times its diameter. In the latter, should the papilla be also the seat of infiltration and swelling, the chief lesions are to be found on the surface of the retina.

The form of retinitis which most nearly resembles neuro-retinitis is certainly the albuminuric form, but in these cases the hæmorrhages and the stellate disposition of the fatty patches round the macula, together with the analysis of the urine, make it difficult to fall into error.

The diagnosis as to its course is also easy. Neuritis, of cerebral origin, usually comes on very rapidly, is binocular, has well-marked ophthalmoscopic signs, is accompanied with mydriasis and cerebral symptoms.

Neuritis from orbital causes is monocular, accompanied by exophthalmos, and with paralysis of some of the different muscles of the eye. Syphilitic neuritis is ordinarily monocular; it is usually engrafted upon a choroiditis, or an old attack of iritis. Thus we generally find posterior synechiæ, floating

bodies in the vitreous chamber, and often manifestations of general syphilis.

Progress. — Neuritis ends generally by atrophy of the papilla, but the atrophy may remain incomplete or stationary if the affection which caused it is susceptible of cure.

Prognosis.—This is very grave, above all if the cause is cerebral. Nevertheless, certain forms of meningitis and syphilitic gummata may be cured, and it is in those cases where the affection is due to syphilis or dysmenorrhœa that the most favourable result may be looked for.

Treatment.—This must, of course, depend upon the cause. If it is cerebral, the ordinary indications to fulfil are the use of blood-letting, blisters to the nape of the neck, mercurial inunctions, iodide of potassium, and finally chloral if there is much cephalalgia.

If the cause is syphilitic, a mixed treatment should be employed.

ARTICLE V.

EMBOLISM OF THE CENTRAL ARTERY.

A BLOOD-CLOT, carried by the current of the circulation, may suddenly obstruct the trunk of the central artery, or merely one of its branches. We may thus have two varieties of embolism:—

1. Complete.
2. Partial.

Complete Embolism.

Functional Symptoms.—Its functional symptoms are very characteristic. The onset sudden, instantaneous, and without pain.

Central vision is completely abolished in the eye affected, so much so that the patient can scarcely distinguish night from day.

Peripheral vision is equally lost, but after a few days a narrow circle, in which light may be distinguished, makes its appearance at the extreme periphery of the field, owing,

no doubt, to the collateral circulation becoming established. Phosphenes are lost.

The affection is almost always monocular, and frequently accompanied by heart disease.

Ophthalmoscopic Symptoms. — At the commencement the appearance is not unlike that of the sudden development of a neuritis, on account of the infiltration of the papilla and the retina, as the result of the obstructed circulation.

The Papilla is pale, its contour indistinct, and masked by serous infiltration.

The Retina. — This infiltration extends often over a large surface of the retina, but is chiefly visible round the macula, where it seems to be minutely punctated. Sometimes are scattered here and there small apoplectic foci.

Macula. — Its aspect is very characteristic. It appears as a red spot, not unlike a minute extravasation. This is due to the fact that this delicate region escaping the infiltration, the normally red colour of the choroid contrasts with the grey tint of the surrounding

parts. Sometimes, however, a real hæmorrhagic spot may occupy the site of the macula.

Large Vessels. — The arteries are thread-like and devoid of blood, as would be expected after the obliteration of their channel. In some cases, however, they seem to retain their normal calibre, owing probably to the circulation being re-established, without, however, the retina regaining its functional activity.

The veins are usually contracted in size in the papilla, but are distended and voluminous at the periphery of the retina. Certain veins seem divided into truncated segments. These become alternately filled and emptied of blood, as though the circulation were carried on in jerks.

Atrophic Period. — After a certain length of time all the retinal infiltration disappears, and we only find signs of atrophy of the papilla, which are usually complete at the end of three months.

Partial Embolism (*Rare*).

Functional Symptoms.—1. Onset sudden.

2. Central vision not much disturbed. 3. Peripheral vision lost on the side opposite the obliterated branch. Loss of phosphenes on the side corresponding to the injury.

Ophthalmoscopic Signs.—The obstructed branch is seen to be devoid of blood. There is infiltration of the retina in all the space supplied by the obstructed branch.

Pathological Anatomy.—Virchow was the first to discover the offending body, in the shape of a blood-clot obstructing the central artery.

Some authors think that the seat of embolism is more frequently in the ophthalmic artery than in the central artery, and obliterates, at the same time, some of the short posterior ciliary arteries. This seems improbable, for, under such circumstances, we should expect to find serious impairment in the nutrition of the choroid, which, on the contrary, never shows any signs of being affected.

How is the circulation re-established in

those cases in which this appears to take place? Either by disintegration of the blood-clot, or by means of the short posterior ciliary arteries, which form round the optic nerve a vascular circle, some branches of which communicate with the central artery. The re-establishment is not followed by restoration of vision, so easily is the delicate function of the retina impaired.

Causes. — Embolism has for its cause a fibrinous clot, formed, as the result of endometritis, either in the heart or some artery, and transported by the current of the circulation.

Diagnosis.—It is the only affection of the eye where there is immediate loss of central and peripheral vision, and all the sensation of phosphenes.

If we glance at the other diseases, in which there is also sudden loss of vision in one eye, spontaneous and without pain, we shall find their characters differ from the preceding, as the following table will show:—

VARIETIES OF ATROPHY.

1. Progressive Atrophy.	2. Atrophy following Optic Neuritis.	3. Atrophy following Embolism.	4. Atrophy following Retinitis Pigmentosa.	5. Glaucomatous Atrophy.
FUNCTIONAL	SYMPTOMS—			
1. Advent slow (3 to 4 months).	1. Advent rapid or slow, according to the case.	1. Advent sudden and instantaneous.	1. Advent very slow (several years).	1. Often follows attacks of glaucoma; slow, insidious in simple glaucoma.
2. Central vision fails first and progressively to blindness which is almost complete.	2. The failure of vision proceeds to a certain point and then remains stationary.	2. Immediate loss of vision, so that the patient can with difficulty tell night from day.	2. Central vision is lost little by little, but always after peripheral vision.	2. Central vision fails gradually, and sometimes after the peripheral.
3. Irregular contraction of peripheral vision happening in the later stages.	3. Idem.	3. Immediate loss of visual field; after several days a little light may appear on the external side.	3. Peripheral vision fails first in a regular concentric manner.	3. Peripheral vision commences to fail on the internal or nasal side.
4. Nyctalopia.	4. Idem.	4.	4. Hemeralopia.	4. Nyctalopia.

5. Progress continuous.	5. Progressive, but sometimes stationary.	5. The sudden blindness is generally final.	5. Progress exceedingly slow.	5. Progressive; perhaps arrested in certain cases by iridectomy.
6. Binocular.	6. Binocular, when the cause is cerebral.	6. Monocular.	6. Binocular.	6. Binocular.
7. Frequently symptoms of some spinal or cerebral disease.	7. Symptoms of cerebral disease.	7. Symptoms of heart disease.	7.	7.
Ophthalmoscopic Appearances—				
Papilla pearly-white, with well defined borders; the large vessels retain for a long time their normal size.	Papilla of a dirty white, margins obscured, arteries diminished in size, veins enlarged and tortuous.	Characters, those of progressive atrophy.	Papilla white, larger vessels reduced to mere threads, black patches of pigment distributed along their course.	Papilla white and excavated, the large vessels hooking over the margins of the papilla, arterial pulsation, atrophy of choroid immediately surrounding papilla.

Amongst the ophthalmoscopic signs, the alteration of the macula is very characteristic. At first sight the infiltration of the papilla might lead one to suppose that the case was one of retinitis. But the suddenness of the attack and the complete loss of vision places the diagnosis beyond doubt, for these never occur in inflammation of the retina.

When atrophy has ensued, we have already seen how it may be distinguished from other kinds of atrophy.

The diagnosis of partial embolism can alone be made with certainty when, with the ophthalmoscope, the obstructed vessel can be seen.

Prognosis. — The eye so attacked must remain for ever blind, restoration rarely if ever taking place. The other eye is rarely attacked. If the affection is complicated with heart disease, of course the prognosis is more serious.

Treatment can do nothing for these cases. But the condition of the heart should be watched over.

ARTICLE VI.

TUMOURS OF THE OPTIC NERVE.

These tumours are rare. The principal varieties are:—

1. Glioma and glio-sarcoma. 2. Syphilitic tumours. 3. Neuromata.

These are the chief characteristics:—

1. Vision is interfered with, and somewhat rapidly lost.

2. There is neither pain nor photopsia.

3. The affected eye presents well-marked signs of optic neuritis.

4. There is exophthalmos when the tumour is of any size.

5. The mobility of the eye is rarely interfered with.

6. The affection is monocular.

CHAPTER III.

AFFECTIONS OF THE RETINA.

The affections of the retina which present themselves for study are:—

1. The different forms of retinitis.
2. The affections of the macula.
3. Detachment of the retina.
4. Tumours of the retina.

ARTICLE I.

RETINITIS.

Under this name are designated the different forms of inflammation of the retina.

According to the different alterations which the ophthalmoscope reveals, we may divide the different forms of retinitis as follows:—

1. Serous retinitis.
2. Exudative retinitis.

3. Apoplectic retinitis.

4. Pigmentary retinitis.

The first three forms are often combined in such a way as to produce the most varied ophthalmoscopic appearances. Nevertheless, certain initial causes impress their own particular stamp upon the disease, and according as these alterations are grouped together, and the functional symptoms combine, we must again study the different forms of retinitis under the following headings:—

Albuminuric retinitis.

Glycosuric retinitis.

Syphilitic retinitis.

Causes.—Idiopathic retinitis is rare. The most frequent causes are:—

1. Diseases of the brain which usually produce neuro-retinitis.

2. Diseases of the heart and vessels.

3. Diseases of the blood (syphilis, albuminuria, glycosuria).

4. Affections of the choroid, owing to their proximity.

I.—Serous Retinitis.

It is characterized by an infiltration of serosity into the cellular tissue of the retina.

Functional Symptoms.—These are uncertain, as in most of the forms of retinitis, which never give rise, as was formerly thought, to pain or photophobia, or to any visible reddening of the external tissues, but simply to a weakening of the visual function.

Onset.—Slow; varying from a few days to a few weeks.

Central Vision.—In some cases scarcely affected; in others the largest characters can hardly be made out. This depends upon the amount of compression to which the nervous elements of the retina are subjected, and this may be to a certain extent appreciated with the ophthalmoscope.

Peripheral Vision is variously affected for the same reasons; sometimes it presents large gaps, or is contracted in a more or less irregular fashion.

Ophthalmoscopic Symptoms. — These alone can establish the diagnosis. They consist—(1) in the loss of transparency of the retina; (2) in congestion of the vessels.

Loss of transparency has for immediate effect the obscuration of the ophthalmoscopic image. Thus the fundus of the eye loses its brilliant reflex and appears dull. The retinal vessels are not seen with the same clearness as usual. The margin of the papilla is veiled, sometimes even obliterated by effusion, in such a way that it is often only recognized by the point of convergence of the large vessels.

The disturbances of the fundus reach their maximum at the spot where the retina is thickest, that is in the neighbourhood of the papilla. They are least distinct where the retina is thinnest, that is at the apex of the macula. It results that this spot looks much redder by contrast than the rest of the retina, and might possibly lead to the idea of hæmorrhage.

This indistinctness gradually diminishes towards the periphery of the retina, which

ordinarily remains clear and transparent, a sign which is of some importance in diagnosis.

Congestion of the Vessels of the Retina.—The papilla, although clouded, looks red on account of the development of its capillary vessels.

The veins of the retina are enlarged, tortuous, and bent. The arteries are usually slightly diminished in size by reason of the compression they are subjected to at the point of entrance, owing to the œdema of the papilla.

Changes in the neighbourhood.—There are often, at the same time, hæmorrhages and exudations upon the retina, but in these cases it is no longer a question of simple serous retinitis, but of some other form of the disease.

Causes.—Œdema of the retina accompanies generally all changes of structure in this membrane, be they exudations or apoplexies, and is a common symptom of all forms of retinitis.

When it exists by itself it constitutes often the first stage of all the different forms of

retinitis, above all of the syphilitic and albuminuric form.

Finally, it may depend upon an impediment to the return of the circulation produced by an affection of the heart or of the great vessels.

Diagnosis.—This reposes chiefly upon the want of transparency in the retina, and consequently of the fundus of the eye. Now, disturbances in the transparency of the refracting media may, under certain conditions, produce an analogous result. With the cornea and crystalline lens it is easy to eliminate any chance of a mistake by the use of lateral illumination. But with the vitreous body, which may become turbid and mask the fundus of the eye with a uniform cloudiness, much resembling serous infiltration of the retina, the diagnosis must be established by the following considerations:—

1. If there is turbidity of the vitreous humour, the cloudiness is always general, perhaps a little more accentuated in the dependent parts, and the fundus of the eye

is as much obscured in the direction of the ora serrata as in the neighbourhood of the papilla.

2. There are often flaky particles floating in it sufficiently large to be visible with the ophthalmoscope.

On the other hand, in infiltration of the retina, the cloudiness is generally confined to the neighbourhood of the papilla, and gradually fades away towards the periphery, where the fundus usually retains its normal colouring. Finally, the indistinct outline of the papilla and the swollen and tortuous condition of the large veins of the retina constitute valuable diagnostic signs of retinal œdema.

Prognosis.—This depends very much upon the course of the malady, but should in any case be guarded.

Treatment.—1. *Local.*—Complete rest; blue or smoked glasses; blisters around the orbit.

2. *General.*—Some mild continuous purgatives; stimulation of the functions of the skin and kidneys; treatment of the presumed cause of the disease.

II.—Exudative or Parenchymatous Retinitis.

Here the condition is no longer simply serous but plastic. In any case the word exudation is not perfectly correct, for it applies to the most different pathological products which the ophthalmoscope is incapable of differentiating, *i.e.*, true effusion of plastic lymph, and the results fatty and colloid degeneration.

Functional Symptoms.—These are not very distinctive.

1. *Onset.*—Slow.

2. *Central Vision.*—Sometimes but slightly diminished, at others so extensively compromised as to prevent the patient from reading the largest type. This depends upon a general law which holds good for the pathology of all the different forms of retinitis. As long as the changes do not affect the region of the macula, there is relatively little amblyopia, but as soon as this region is affected vision becomes rapidly diminished.

3. *Peripheral Vision.*—It presents gaps

corresponding with those portions of the retina in which the exudation has taken place.

4. There is colour blindness in some cases.

Ophthalmoscopic Symptoms. — The exudations upon the retina show themselves in the form of white patches, which are distinctly visible with the ophthalmoscope; they are generally situated in the neighbourhood of the papilla, along the course of the larger vessels, and in the region of the yellow spot.

The seat of these patches is in the anterior layers of the retina; more rarely they occupy the posterior layers. The positions they hold in this respect can be in a measure determined by observing whether the large vessels lie upon or below them.

In form they are usually irregular, their margins being usually rounded when seated in the deeper layers. When more superficially placed they are striated, and call to mind the direction of the nerve-fibres. Sometimes they run along the sides of the vessels in the shape of narrow bands (perivascular retinitis).

Their colour is usually of a greyish-white,

the more brilliant the greater the amount of fatty elements they contain. Sometimes they appear in the form of a number of small isolated points, at others in the shape of patches, having a diameter equal to that of the papilla, or larger. Their borders fade gradually into the opalescent tint of the circumjacent retinal œdema; they are never bordered by pigment. The chief alterations which take place in their neighbourhood are the swelling and infiltration of the papilla and parts of the surrounding retina, and occasionally the presence of small hæmorrhagic effusion.

Causes.—These are the same as we have assigned for retinitis in general.

Diagnosis.—Under this heading two principal points arise for consideration. Either the exudative patch is placed in front of the retinal vessels, which it obscures or partially conceals, or it is situated behind the vessels, which pass clearly before it. In the first case its seat is in the anterior layers, and

it can only be mistaken for congenital opaque nerve-fibres, for these are white and striated like an exudation, and in like manner mask the retinal vessels. In the second case it is situated in the posterior layers, and may be mistaken for an exudation patch in the choroid, or for a patch of atrophy in this membrane, for the retinal vessels pass in front of each of these kinds of alteration.

These are the elements for forming a diagnosis :—

EXUDATIONS IN THE ANTERIOR LAYER OF THE RETINA.	CONGENITAL OPAQUE NERVE-FIBRES.
1. They are striated and have their seat along the larger vessels, which they partially cover.	1. The same, but their most usual position is the side of the papilla opposite to the macula, that is to say, the external side in the inverted image.
2. They exist in one or both eyes.	2. Almost always exist in both eyes.
3. They do not invade the disc itself.	3. Often trench upon the disc up to the point of emergence of the great vessels.
4. The papilla and the retina in the neighbourhood of the exudation are infiltrated.	4. No infiltration of the papilla or of the retina in the neighbourhood.

EXUDATION INTO POSTERIOR LAYERS OF RETINA.	EXUDATION OF THE CHOROID.	ATROPHIC PATCHES.
1. *Situation.*—They are usually situated by the side of the retinal vessels, which pass distinctly in front of them.	1. They are usually situated in the spaces between the retinal vessels instead of along their course.	1. Occupy the same situation as the choroidal exudations.
2. *Shape.*—They have no special shape. Sometimes they are rounded, sometimes elongated, or in the form of irregular patches.	2. The same.	2. Shape always approaching circular or in the form of a number of arches blending into each other.
3. *Colour.*—The colour is usually of a brilliant white.	3. Colour of a dirty white or yellowish white.	3. Variable, usually bluish. Mother-of-pearl tint very characteristic.
4. *Surface.*—Stands out in relief if the exudation is abundant, and raises up slightly the retinal vessels, which pass over it This then assumes a slight change in colour, and appears darker.	4. It is rare that the exudation is sufficiently abundant to raise up any vessel which passes over it.	4. The surface appears hollowed out, and here and there may be seen little pigment patches, and the remains of the vasa vorticosa incompletely atrophied.
5. *Margins.*—Surrounded by infiltrated retina. The retinal vessels are large and tortuous. There is never any bordering of pigment.	5. The surrounding retina not infiltrated. Vessels of normal size; margins of exudation sometimes bordered with pigment.	5. Margins abrupt and defined, frequently mapped out by pigment deposits. The choroid in neighbourhood often somewhat denuded.
6. Changes in neighbourhood, often accompanied by striated retinal hæmorrhages.	6. Rarely accompanied by retinal hæmorrhages, but often by opacity of vitreous.	6. No other alteration of the fundus in general. Opacity of vitreous rare.

When the patch of retinal exudation has been recognized, we must try and discover its cause.

When the exudations, accompanied or not, as they may be, with hæmorrhages, exist in one eye alone, they will give rise to a suspicion either of some affection of the heart or great vessels, or to a disturbance of the general circulation due to uterine derangement, suppressed hæmorrhoids, or syphilis.

When they exist in both eyes they are more frequently due to albuminuria, or to some cerebral cause if the disease presents itself in the form of neuro-retinitis.

Progress and Prognosis.—What becomes of the patches of exudation? They may become absorbed and vision become perfect, but this must depend upon the changes produced in the nerve-elements which have been submitted to compression, so that the prognosis ought always to be guarded.

Treatment has for its object to favour the absorption of the exudation, and consists

of repose of the eyes, mercurial inunctions, slight purgatives, and the administration of iodide of potassium.

The general treatment of the disease which may have given rise to the retinitis must also be followed out.

III.—Retinitis Apoplectica.

When a retinal vessel gives way, the extravasated blood may take different courses.

It may spread between the choroid and the retina, giving rise to a separation or detachment of the latter. Or it may pass between the retina and the hyaloid membrane. This event almost exclusively takes place in the neighbourhood of the macula. At these points the retinal vessels may be seen to disappear behind the hæmorrhages. Or again, it may pass into the vitreous body, after having ruptured the limiting and the hyaloid membrane, and appear as black flakes. This, however, is rare. Finally, it may infiltrate the thickness of the retina

itself. This is the most frequent event, and it is this condition which constitutes the retinitis apoplectica, of which we are going to treat.

Functional Symptoms.—These are unimportant. The onset is rapid. Central vision is only slightly affected unless the macula has been invaded; if this has occurred it is necessarily seriously impaired. Peripheral vision is usually intact. Some patients complain of seeing objects coloured red, green, or yellow.

Ophthalmoscopic Symptoms. — 1. *Aspect.*—There are patches of ecchymosis of a deep red, manifestly impinging on the rosy tint of the fundus.

2. *Situation.*—Their seat of predilection is the macula (one in five times) and the neighbourhood of the papilla in the course of the larger vessels. It is rare to observe them in the peripheral parts of the retina.

3. *Shape.*—They are usually oblong, sometimes, however, with tapering points, especially

when they are seated in the anterior layers of the retina, because they then follow the direction of the nerve-fibres. They are more usually circular or rounded when seated in the posterior layers of the retina.

4. *Colour.*—This is usually of a deep red if the hæmorrhage has been relatively abundant, less red under other circumstances. In any case the colour will vary according to the period of examination. It becomes paler with time, gradually assuming a yellow colour, and eventually disappearing altogether, without leaving a trace. In certain cases, however, an indelible white patch is left, due to atrophy of the nerve-tissue at the affected spot.

5. *Extent and Number.*—They are sometimes very small and very numerous (punctated hæmorrhage of retina). Sometimes only one patch exists, having a diameter several times as large as that of the papilla.

6. *Margin.*—Its margin is generally abrupt, and separates it distinctly from the neighbouring parts.

7. *Origin.* — Sometimes, though rarely, arterial—generally in heart disease and glycosuria; venous in albuminuria and syphilis. They are usually, however, capillary. It is by their immediate relationship with the arteries and veins that we judge of their origin. In cases of arterial hæmorrhage the artery may be obstructed by a clot and remain empty of blood.

8. *Alterations in the Neighbourhood.*—The papilla, and the parts of the retina near to the hæmorrhagic spot are infiltrated, but in the end this infiltration disappears; often patches of exudation are interspersed amongst the apoplectic ones.

Causes.—Hæmorrhages of the retina are a frequent symptom of different varieties of retinitis, but chiefly of albuminuric retinitis; they are then accompanied with other alterations in its structure.

When hæmorrhage upon the retina appears as a disease by itself, it is usually monocular. We must then look for its cause amongst the following affections:—

1. Affections of the heart and vessels (atheromatous degeneration).

2. In some disturbance of the circulation, produced by suppression of the menses, a hæmorrhoidal disease, or some violent strain.

3. In some traumatic cause. They are not of infrequent occurrence after irideetomy from the sudden diminution of intraocular pressure.

4. Finally, they constitute sometimes the initial phase in certain irregular forms of glaucoma, and it is always advisable in these cases to examine with care the tension of the globe.

Diagnosis.—We must not confound an hæmorrhagic patch upon the retina with an apoplexy of the choroid. The latter is much more rare; it shows no immediate relations to the large retinal vessels, is ordinarily situated at the periphery of the fundus, produces no œdema of the surrounding retina, and is often accompanied by other affections of the choroid.

We have seen that sometimes the normal coloration of the macula may, by contrast,

be mistaken for an hæmorrhagic spot. The examination of the acuity of vision will prevent us, however, falling into this error.

Prognosis. — A retinal hæmorrhage in itself is not very serious, if it does not impinge upon the macula; but in this situation it may produce permanent loss of central vision. Vision may, however, be restored in the course of six months or a year.

Arterial hæmorrhages are more dangerous than venous ones. Those due to syphilis may be re-absorbed after a couple of months' treatment.

If the presumed cause is disease of the vessels, we must bear in mind that the cerebral capillaries may become involved, and that the patient will always be in danger of some cerebral complication.

Treatment.—This must be directed to the absorption of the effused blood. Atropine; stimulating embrocation to the temples and surrounding parts; warm douches to the eyes.

To prevent the return of hæmorrhage, slight purgatives, warm mustard foot baths, leeches to the anus, and digitalis may be administered. The general treatment of the cause of the malady should, of course, be instituted.

IV.—Retinitis Pigmentosa.

Retinitis pigmentosa and choroido-retinitis pigmentosa are synonymous expressions used to designate this affection, which is characterized by the infiltration of choroidal pigment into the substance of the retina as the result of the atrophy and softening of the latter membrane.

There are two varieties of this disease—congenital retinitis pigmentosa and syphilitic or acquired retinitis pigmentosa (Galezowski).

Congenital Retinitis Pigmentosa.

Functional Symptoms.—These are very characteristic, and of themselves are often sufficient to establish the diagnosis.

Onset.—Extremely slow, often dating from infancy, and revealing itself by persistent hemeralopia.

Central Vision.—This remains intact for a very long period of time, contrasting with the progressive and concentric contraction of peripheral vision. Thus we see patients who are able to read the finest print, who cannot find their way in the streets, for they can see nothing but what occupies the point of fixation. Finally, however, central vision is enfeebled and gradually lost.

Peripheral Vision becomes restricted long before central vision is affected. So contracted does it sometimes become as to leave a visual field which does not extend over more than one or two centimetres.

Hemeralopia is one of the first symptoms to appear, and persists during the whole duration of the disease. The retina, whilst undergoing the process of atrophy, loses its excitability and cannot execute its functions except under intense illumination.

Nystagmus (vacant look). — On account of the loss of peripheral vision, the patient

can no longer see an object at one glance. He is obliged to fix successively each part of it. This gives rise to a great mobility of the eye, amounting often to a complete nystagmus. The affection is always binocular. Its progress is extremely slow, blindness rarely occurring under thirty or forty years.

Ophthalmoscopic Symptoms. — The papilla keeps, for a certain length of time, its normal tint, but finally ends in becoming atrophied.

Atrophy of the Large Vessels.—What is very characteristic in these cases is the gradual wasting of the large vessels, which become reduced to the finest threads, and sometimes even disappear altogether as the result of sclerosis of their walls.

Pigmentation of the Retina. — The peripheral parts are covered with little pigment patches scattered here and there. These patches are of a deep black colour and star-shaped, often surrounded by little striæ, also of a deep black. The patches are chiefly abundant in the course of the large vessels,

and advance gradually towards the papilla, giving to the fundus of the eye a striped, tiger-skin appearance, which is very characteristic.

Alterations of the Choroid.—These are not so marked, and consist chiefly in a disappearance of the epithelial layer, laying bare the vasa vorticosa.

Crystalline Lens.—It has been observed, not infrequently, that a posterior polar cataract, which remains, however, stationary, not infrequently develops in these cases.

Such are the changes which take place in this disease. In the end the papilla becomes completely atrophied, when the affection changes its name, and is designated as an atrophy of the papilla due to retinitis pigmentosa.

Causes.—These are very obscure. We may mention the influence of hereditary predisposition and the coincidence of this affection with idiocy, deaf muteness (Graefe), the existence of supernumerary fingers and toes (Wecker). Liebreich attributes it to

the consanguinity of parents, Galezowski to hereditary syphilis.

Syphilitic Retinitis Pigmentosa.

This not infrequently develops as a sequence to specific choroiditis.

Functional Symptoms.—The commencement is that of specific choroiditis. Finally, hemeralopia supervenes, and contraction of the field of vision and diminution of central perception. The only difference in the functional symptoms is the absence of photopsiæ and the more rapid progress of the affection.

Ophthalmoscopic Symptoms. — These most resemble the preceding variety, but with these differences:—

The patches of pigment with which the retina is infiltrated are larger than in the congenital form, and are ordinarily circular in shape. The choroid has undergone much change, and shows here and there patches of

atrophy or of exudation. There is frequently some general cloudiness of the vitreous body.

Atrophy of the papilla comes on somewhat rapidly.

Pathological Anatomy. — The essential characteristic of retinitis pigmentosa is atrophy of the retina, of which we can judge by the atrophy of the larger retinal vessels. This atrophy commences at the periphery, and advances progressively towards the central portions. The choroid is always affected, so that in effect a better name for this malady is choroido-retinitis pigmentosa. The choroid furnishes the pigment which becomes infiltrated into the retina, as the result of softening of the latter membrane. Donders thought, erroneously, that it was secreted entirely by the retina.

Diagnosis.—This can sometimes be made by means of the functional symptoms alone. Thus, any patient who complains of persistent hemeralopia, and who presents a concentric contraction of the field of vision, is almost sure to be the subject of retinitis pigmentosa.

We can thus see how important are these two symptoms when combined.

The ophthalmoscopic symptoms are also well defined. Nothing is easier to make out than the diminution of the retinal vessels, and above all the pigmentation of the peripheral portions of the retina.

We must not confuse this condition with the large masses of pigment deposited in the choroid as the result of the atrophic forms of choroiditis. Here they are scattered round the large white patches which are spread over the fundus of the eye. They are neither accompanied by hemeralopia nor contraction of the field of vision, and the retinal vessels retain their normal calibre.

Syphilitic retinitis pigmentosa differs from the congenital form, in that the pigment deposits in the former appear as circles or half-circles, by the concomitant alterations in the choroid and vitreous, by the method of onset, and the progress of the malady.

When atrophy of the papilla is complete, we have pointed out above how its different varieties can be distinguished.

Progress.—This is slow, blindness only resulting at an advanced age. In the syphilitic form the results are more rapid, and four or five years is sufficient to produce blindness.

Prognosis is always of the gravest.

Treatment.—All forms of treatment are equally without avail—electricity, hydropathy, tonics, iodide of potassium.

V.—Retinitis Albuminurica.

This is the form of retinitis occasioned by albuminuria (one in ten), be it the result of Bright's disease, pregnancy, or scarlet fever.

Functional Symptoms exhibit nothing specially characteristic.

Onset slow.

Central Vision scarcely diminished, as long as the macula is unaffected, however great may be the changes in the remainder of the fundus. Sight becomes seriously

impaired as soon as the yellow spot becomes invaded.

Peripheral Vision is usually retained.

Daltonism, in advanced cases, is usually present.

The affection is always binocular.

General Symptom of Albuminuria.—Albumen in the urine.

Ophthalmoscopic Symptoms.—Of all the forms of retinitis it is the one which offers the most constant and well-defined type. As Liebreich has pointed out with truth, we can often establish a diagnosis of albuminuria by the use of the ophthalmoscope alone.

Papilla.—This is always infiltrated as well as the neighbouring retina, and often to such an extent that some authors speak of the disease as neuro-retinitis albuminurica.

Fatty Degeneration and Patches of Exudation in the Retina.—Beyond the zone occupied by the infiltration, and not far from the papilla, we find white patches of fatty degeneration

and exudation; some are very small, others are larger. They are chiefly situated in the course of the large vessels, which, here and there, they not infrequently obscure.

Alterations in the Yellow Spot.—Around the yellow spot these little dots of fatty degeneration are grouped like stars in the firmament. They are often very persistent, and remain long after the real disease has disappeared.

Linear Apoplexies. — These hæmorrhages are situated in the spaces between the patches of fatty degeneration. They are frequently very numerous, usually linear and elongated, and venous in their origin. Some few are fusiform, for they sometimes occur in the sheath of the vessel itself, making it appear as though it were double its real size.

The changes always exist more or less in both eyes.

The peripheral portions of the retina are healthy, as is also the choroid and vitreous body.

Cause.—The presence of albumen in the

urine is the cause, but what is its method of action? Is it because there is often at the same time hypertrophy of the heart, and consequently increased tension throughout the arterial system? Is it because the blood itself has undergone a change, as well as the vascular walls? The last interpretation seems the most logical.

Diagnosis.—This is easy, as we can always derive confirmation from the examination of the urine.

The affections with which it might be confounded are:—

1. *Certain Cases of Neuro-retinitis of Cerebral Origin.*—In these the hæmorrhages are large instead of being like thin lines, and the patches of exudation are less abundant. The error has, however, been committed by a no less skilled observer than Graefe; we should, therefore, always employ a certain amount of circumspection in these cases, and never neglect the examination of the urine.

2. *Certain Exceptional Forms of Glycosuric Retinitis.*—The latter form of retinitis is rare,

and in it the papilla is rarely infiltrated; exceptionally, however, there may be a resemblance between the two.

Other varieties of retinitis may sometimes deceive us, but if we adopt the wise practice of always examining the urine in cases where retinitis is binocular, accompanied by hæmorrhages and infiltration of the retina, we shall rarely go astray.

Progress.—The progress of the case is always slow and somewhat intermittent. Sometimes the retina becomes detached, and occasionally the papilla atrophies, as in neuro-retinitis.

Prognosis.—As far as the visual functions are concerned, it is rare for albuminuric retinitis to lead to complete blindness, but we can only expect a radical cure when the disease is not symptomatic of Bright's disease. It is the general affection which renders the prognosis so serious.

Treatment.—This must be directed against

the cause. Cupping or scarifications in the lumbar region; sulphur baths; iodide of potassium internally; tonics; diuretics, and a generally tonic plan of treatment.

VI.—Glycosuric Retinitis.

This kind of retinitis is a pathological rarity. If diabetes is often attended with some disturbance of vision, this is most frequently due to weakening of the power of accommodation, leading eventually to a premature development of presbyopia, to opacity of the lens, to atrophy of the papilla, and finally to amaurosis unattended with any appreciable alteration of the fundus.

Functional Symptoms. — They present no very definite signs, and may be summed up in a failure, more or less marked, of central vision.

Ophthalmoscopic Signs. — The papilla, contrary to what we generally see in albumi-

nuric retinitis, is not infiltrated, but it shows a great tendency to become atrophied; while patches of exudation and hæmorrhagic spots, circular in form, and usually of arterial origin, are scattered throughout the retina.

Diagnosis.—This form of retinitis has so few special characteristics, that the analysis of the urine can alone establish the diagnosis.

Treatment. — The same as for diabetes. Gluten bread; tonics; exercise, and hydropathic treatment generally.

VII.—Retinitis Syphilitica.

Syphilitic retinitis, as a disease *per se*, is not of very common occurrence. Syphilitic choroido-retinitis is, on the contrary, very common, and in these cases it is almost always in the choroid that the malady has commenced, which has subsequently become propagated to the retina.

Functional Symptoms.—*Onset* slow.

Central Vision.—Often much more interfered with than the ophthalmoscopic image would lead one to suppose. This is just the opposite of what occurs in most forms of retinitis. In any case, the diminution is always in proportion to the structural changes of the macula. As this region is frequently liable in these cases to be attacked, we often observe central scotomata and symptoms of distortion and micropsia, which are peculiar to changes of the yellow spot.

Peripheral Vision.—It is either intact, or presents, here and there, gaps, corresponding to the alterations of the retina when these are of considerable size.

Photopsiæ are of frequent occurrence, and Daltonism is not infrequently observable in advanced cases.

The progress of the malady is subject to critical exacerbations, during which sight is much enfeebled.

The affection is usually monocular.

Ophthalmoscopic Symptoms.—There

is infiltration of the papilla and the neighbouring retina, principally on the side of the macula, with hyperæmia of the large veins.

This infiltration, which is common to other kinds of retinitis, shows sometimes in these cases a very interesting peculiarity. It gives to the fundus of the eye a bluish-grey appearance; sometimes this occupies but one segment of the papilla, and then seems to extend by preference along the course of one of the large vessels.

Apoplectic Patches.—Their existence in this form of retinitis is not a rule, as it is in the albuminuric form, but they may be more or less numerous in the course of the large vessels, and they are, too, of venous origin.

Patches of Exudation.—We find, sometimes, more or less numerous patches of exudation, of varying size, either in the anterior or posterior layers of the retina.

Alteration of the Macula.—These exudations chiefly occur in the region of the macula. Here they do not present such a brilliant reflex, nor the star-like grouping which we see in nephritic retinitis. They are little

punctated opacities scattered here and there; they often disappear after a few days to reappear again very soon, constituting the central recurrent retinitis of Graefe.

Changes in the Neighbourhood.—The choroid often participates in the affection, as is seen by the presence of exudative or atrophic patches, by cloudiness and flocculent bodies in the vitreous. The disease then is called choroido-retinitis.

Diagnosis.—The functional and ophthalmoscopic symptoms above described would barely suffice to establish a diagnosis if we did not find in the eyes other syphilitic manifestations, such as the traces of old iritis, cloudiness of the vitreous, peri-neuritis, or paralysis of the third, fourth, or fifth nerves, or perhaps interstitial keratitis. We know, in effect, that one of the peculiar effects of syphilis is to attack simultaneously, or at very short intervals, different membranes of the eye.

Prognosis.—It is not unfavourable at the

commencement; we may hope to cure the malady at the end of two or three months' treatment. On the other hand, the prognosis is very serious in rebellious cases, atrophy of the papilla not infrequently supervening.

Treatment. — Here we should adopt a mixed kind of treatment—mercurial frictions, iodide of potassium, sulphur baths, etc.

ARTICLE II.

AFFECTIONS OF THE MACULA.

Alterations of the macula are due to changes of the retina or of the choroid. They are of the same essential nature as the other diseases of these membranes, but as they are sometimes limited to this region only, it is useful to describe them apart for they have many characteristic symptoms.

Functional Symptoms common to these affections.—*Onset* is always sudden, whenever it is a question of hæmorrhage or

exudation. It is, on the contrary, slow, if a patch of atrophic choroid is invading this region.

Central Vision: Scotoma.—The patient has a black patch of varying size in front of his sight, the outline of which he can map out, and which always occupies the point of fixation.

It is this spot, or scotoma, which interrupts central vision in a varying degree. Some can still make out ordinary letters, but the words appear interrupted or broken. Others can see nothing at the point of fixation, being able only to recognize the surrounding objects.

Metamorphosia.—It is thus we designate the change of shape which objects sometimes assume. Some patients, for example, see the letters of a word broken up; straight lines seem bent or twisted This depends upon a raising up of the nervous elements of the retina by inflammatory exudation.

Micropsia. — Patients sometimes complain of seeing objects smaller than they are in reality. If they are asked to draw a circle with the affected eye, they make it smaller than with the other.

Peripheral vision is unaffected, so that the patient can still continue to go about and follow his usual occupations.

The affection is usually monocular, and not progressive.

Ophthalmoscopic Symptoms.—It is by means of the ophthalmoscope alone that the true nature of the changes can be made out. They may be of three kinds—(1) exudations; (2) hæmorrhage; (3) atrophic patches of choroid. These are distinguished by the characteristics we have before pointed out.

Diagnosis.—The functional symptoms are characteristic. They may be found, it is true, in detachment of the retina when this membrane forms folds at the seat of the yellow spot or drop upon this region. But the other symptoms will prevent any mistake in the diagnosis.

Prognosis. — This is always somewhat serious, owing to the delicacy of this region; nevertheless, in some cases, central vision may be completely restored

Treatment.—The same as for other forms of retinitis.

ARTICLE III.

DETACHMENT OF RETINA.

This is an affection which is characterized by a more or less considerable separation of a portion of the retina.

Functional Symptoms.—Taken together they enable us to form an almost certain diagnosis.

Onset.—Sudden, without pain, and without change in the external appearance of the eye.

Central Vision is immediately diminished to such an extent that the patient cannot read large letters; sometimes, even, can count fingers only with difficulty.

Deformed Images, or Metamorphosia.—Large objects appear sometimes to the patient distorted, curved, or twisted. This depends upon the impression of the image falling partly on

a healthy portion, partly on a detached portion of the retina.

When the detachment drags upon the retina, small objects, such as letters, appear broken and cut in two, as in the affections we have described as peculiar to this region.

Peripheral vision is abolished in that part of the field corresponding with the detachment. Usually the separation is in the lower portions of the retina; therefore, the abolition of sight will be in the upper part of the field.

Phosphenes are abolished in the part corresponding with the detachment.

Photopsia and chromopsia are of frequent occurrence, owing to the dragging upon the retina. Some patients see objects coloured blue, violet, etc.

The affection is almost always monocular, and is most frequently met with in myopic eyes.

The tension of the globe is diminished when the detachment is of old standing.

Ophthalmoscopic Symptoms.—These

are looked for either with the mirror alone, or with the mirror in conjunction with the lens.

With the mirror alone, we can see an enlarged and erect image of the detached retina, since the latter lies in front of the dioptric system of the eye. It is impossible to illuminate the fundus of the detached portion of the retina, because the latter has lost its transparency, and the subjacent fluid prevents the reflex from the choroid. In other parts of the fundus the eye retains its normal colouring. In the majority of cases, the detachment is in the lower half of the retina, but it nevertheless sometimes occurs in the upper half. When this happens, not infrequently, the fluid, by force of gravity, makes its way to the most dependent portions of the fundus, and the retina above becoming again adherent, may regain its normal functions.

The detached portion of the retina forms a kind of fold or folds of a bluish white appearance, the extreme limit of which, extending up to the ora serrata, cannot be seen.

The detached folds of the retina, not being completely filled with fluid, show, at each movement of the eye, undulatory, tremulous movements, which are very characteristic and unmistakable.

The retinal vessels are seen passing over the detached portions. They move with it, executing the same tremulous and undulatory movements. Owing to an optical illusion, they appear of a blackish tint.

With the mirror and the lens together, all the previous indications are confirmed, but we are enabled further to see—

1. *The Distortion of the Retinal Vessels.*—We mean by this, the change of direction which these vessels assume when they pass from the normal to the detached portion of the retina. At this point we see them bend in the form of a hook, or elbow, at times disappearing completely behind the fold of detached retina, to reappear again in another direction.

2. *The Condition of the Papilla.*—This is often red and congested, it giving evidence of a posterior staphyloma, an index of the myopia which has given rise to the detachment.

3. *Condition of the Retina.*—This is not infrequently torn at the summit of the detachment. This is recognized by the margins of the rent, which are seen either floating in the vitreous or rolled up on themselves, or the possibility of seeing, at this spot, the normal colouring of the choroid.

Complications.—The usual complications of detachment are:—*Floating bodies in the vitreous.* This is of such frequent occurrence, that if we meet with numerous floating bodies in the vitreous, we should always suspect the existence of detachment of the retina. *Iritis*, by propagation of inflammation from the choroid to the iris. *Cataract*, for the altered choroid only imperfectly nourishes the lens. *Atrophy of the globe*, when the ciliary body has undergone such changes that the secretion is diminished or abolished.

Pathological Anatomy.—The detached portion of the retina loses its transparency, and, in the end, undergoes fatty degeneration. Sometimes small apoplectic patches are seen

in the neighbourhood of the detached portions. In the choroid, atrophic patches may also, frequently, be seen; it is the increased abundance of its secretion which gives rise to the detachment.

The effused liquid is of a serous nature, rich in coagulable principles. Sometimes it consists of blood, chiefly as the result of some accident to the globe.

Causes.—Myopia is the most frequent cause of detachment. Next in order comes serous or hæmorrhagic effusions between the retina and the choroid; tumours of these membranes; exudation products deposited in the vitreous body, and wounds of the sclerotic.

How is the detachment brought about? We will describe the mechanism, as laid down by different authors.

1. *Detachment by Distension.*—This occurs in the myopic eye. We know that the eye, already too elongated, has a great tendency to become increased under the compressing influence of the muscles of the globe in the

efforts of convergence and accommodation. The sclerotic and choroid, which are intimately connected and sufficiently elastic, yield to this compression, but the retina, which is less elastic, cannot give way to this movement of distension, and being but loosely attached to the choroid, suddenly gives way and becomes separated.

2. *Detachment by Uplifting of the Retina.*—This condition of things would not come about did there not previously exist—(1) a softening of the vitreous body; (2) a secretion of serous liquid under the retina, produced by the choroidal vessels, always more or less altered and distended in cases of myopia. According to this theory, the uplifting plays a more important part in the pathology of detachment than the distension of the choroid. This upheaval of the retina is chiefly evident in cases of effusion of blood in front of the choroid, and in cases of tumours of the deeper structures, which push the retina before it.

3. *Detachment by Attraction.*—False membranes developing in the deeper portions of the vitreous body and adhering to the retina,

may become retracted, and thus separate the nervous structure. The same may be said of a cicatrix of the sclerotic, which, embracing the retina in its retraction, may separate it at some distant point.

Diagnosis.—We must first recognize the existence of detachment, and then discover its cause.

Existence of Detachment.—The diagnosis is usually very easy, the functional symptoms themselves, in typical cases, enabling us to determine its existence. Thus, any myopic eye which suddenly loses central vision over a more or less extensive surface, together with the upper portion of the field, the lower phosphene being also lost, is certainly suffering from detachment of the retina.

With the ophthalmoscope, there is no fear of a mistake being made, unless it be with false membranes deposited in the vitreous body. These, however, bear but a slight likeness to detachment. They never have vessels running over their surfaces, and if they are detached and have a free margin,

the way in which they float in the vitreous is very different to the oscillation *en masse* which takes place in detachment.

In some cases the diagnosis may be more difficult. Notably, when the detachment occupies a small surface, and the retina has not lost its transparency. The minute inspection of the vessels will prevent us from falling into error; for in the region of the detachment they assume a darker colour, and, in passing over this space, they become slightly bent, sometimes curved and tortuous, executing a tremulous motion each time the eye is moved.

When it is impossible to illuminate the fundus of the eye, either on account of floating particles in the vitreous or opacity of the lens, both which complications are not infrequent accompaniments of detachment, we must always bear in mind the possibility of its existence; above all, in cases of monocular cataract in the infant and adult, and generally in all traumatic cataracts.

It is by the functional symptoms that we may establish a diagnosis. If there are simply floating opacities or an ordinary

cataract, the patient should easily distinguish night from day, or even the light of a lamp placed at the distance of three or four yards. There will be no gaps in peripheral vision, as may easily be ascertained by moving a lamp in the different portions of the field. Finally, all the phosphenes are present, and intraocular pressure is normal. All these features are absent when detachment exists or complicates the case.

Causes of Detachment.—The cause is generally easy to make out. Nevertheless, we must bear in mind that tumours of the fundus not unfrequently, in the early stages, are concealed by a detachment, and these cases should not be confounded with cases of simple detachment.

The progress of these cases is usually slow; sometimes they remain stationary. In the end the detachment may become general (funnel-shaped detachment). The eye then becomes softened, and finally atrophies.

Prognosis is very serious, cases of cure being exceedingly rare. Fortunately, experi-

ence points out that the affection is almost always limited to one eye.

Treatment.—*Surgical:* Sichel was the first who suggested the evacuation of the effused fluid by means of a puncture. Graefe attempted to make a rent in the retina, in order to enable the fluid to escape into the vitreous body, and Bowman suggested this should be done with two needles. Wecker withdraws the fluid first with a trocar, and subsequently makes an aperture in the retina. The different operations have not, however, been attended with very satisfactory results, and they may set up suppuration of the globe.

Medical.—Repose of the eyes. The interposition of an opaque glass before the affected eye, the defective vision of which often interferes with its fellow.

ARTICLE IV.

TUMOURS OF THE RETINA.

Tumours of the retina are either gliomata or glio-sarcomata (Virchow).

Symptoms.—*Period of Commencement.*—The growth at first produces no visible change in the eye, and there is no pain or inflammation. Visual disturbances are more or less pronounced, but rarely complained of by the patients, which are usually small children.

With the ophthalmoscope, small rounded spots of a white or rose colour are seen; some of them are raised. The large vessels are sometimes enormously developed. It is, however, rarely that we are called upon to examine the eye at this period. Later on the retina becomes detached over the whole surface. The fundus of the eye has now a brilliant metallic reflex, easily seen with the naked eye (amaurotic cat's eye).

In proportion as the tumour grows, the intraocular pressure increases, and veritable glaucomatous condition becomes manifest. In the end the tumour propagates itself along the optic nerve, as may be recognized by a slight degree of exophthalmos, or else it perforates the cornea or sclerotic. It then assumes the form of large red and bleeding

excreseenees, seereting an abundant ichorous fluid.

The soft parts of the orbit become rapidly invaded, and the tumour spreads in the neighbouring tissues, or appears in distant organs, most frequently the liver. It is rarely that any suppurative process complicates the history of an intraocular tumour, but in any ease it never interferes with the destructive process of the glioma.

This affection only attacks children from three to fifteen years of age; it is unknown after this period.

Its hereditary nature is pointed out by all authors, and it frequently is found in children of the same family.

Diagnosis.—The aspect of the fundus known by the name of "cat's eye" is one of the most important eharacteristics. Beer looked upon it as a pathognomonic sign of cancer of the retina, but it may also be met with, but less often, in sarcoma of the choroid, in certain cases of suppurative choroiditis, where the retina has become

detached. We must not mistake this affection for

Sarcoma of the Choroid.—The age of the patient is an excellent diagnostic sign. There is no such thing as glioma of the retina after fifteen years; on the other hand, sarcoma of the choroid never occurs before fifteen or twenty years of age, and is most common between forty and fifty years.

Suppurative Choroiditis.—In this the colour of the fundus is more yellow. The presence of pus usually gives rise to some reaction. Finally, intraocular tension, in these cases, is generally diminished, whilst in intraocular tumours it is increased.

The disease is always progressive, and runs its course in from three to four years.

Prognosis is always very serious, inasmuch as the two eyes are not infrequently attacked successively, and the disease is very liable to recurrence.

Treatment.—Enucleation of the globe is imperatively called for.

CHAPTER IV.

CHOROID.

It is the blood contained in the numerous vessels of the choroid which gives to the fundus of the eye the red colour with which we are so familiar. This colouring depends in a great measure upon the amount of pigment deposited in the membrane. If the epithelial layer is very rich in pigment it hides everything which is behind it, and the fundus of the eye appears of a uniform red colour, more or less deep. On the other hand, if there is but a small quantity of pigment in the epithelial layer, we are enabled distinctly to see the vessels of the stroma. If the stroma itself contains much pigment the large vessels alone are apparent, and separated from each other by greyish interspaces. On the other hand, if it is not abundant, the smallest

ramifications of the choroidal vessels are seen.

These vessels are seen in the form of flattened ribbon-like bands of a red colour. They cross each other, and anastomose in all directions (vasa vorticosa), never exhibiting the phenomenon of double bordering. They are chiefly abundant in the neighbourhood of the ora serrata. The characters we have described above distinguish them at a glance from the retinal vessels. It is impossible to discriminate between the arteries and veins.

Affections of the Choroid.—We must study successively:—

1. Choroiditis.
2. Apoplexies of the choroid.
3. Rupture of the choroid.
4. Detachment of the choroid.
5. Tumours of the choroid.

CHOROIDITIS.

Under the name of choroiditis the most dissimilar affections of the choroid are designated.

According to the nature of the alterations, we may divide them into—

1. Serous choroiditis, or glaucoma.
2. Exudative choroiditis.
3. Atrophic choroiditis.

To these principal varieties we may add the two following, which owe to their origin special characteristics.

4. Sclero-choroiditis postica.
5. Syphilitic choroiditis.

In this division the forms of choroiditis which are purely inflammatory are not comprised, such as purulent choroiditis, irido-choroiditis, etc., for they do not come within the province of the ophthalmoscope.

ARTICLE I.

SEROUS CHOROIDITIS, OR GLAUCOMA.

EXCAVATION of the papilla is the special and pathognomonic sign of this disease. It has been described under the head of affections

of the papilla, and to this we must refer the reader.

ARTICLE II.

EXUDATIVE OR DISSEMINATED CHOROIDITIS.

It is chiefly characterized by the exudations which are deposited either in the substance or on the surface of the choroid, the situation being almost impossible to differentiate.

Functional Symptoms.—These are not very characteristic. The onset is slow. Central vision is more or less compromised according to the position of the exudation in relation to the macula, as in cases of retinitis. Generally speaking, the visual disturbance is relatively more marked in these cases than in the atrophic forms of choroiditis, owing to the compression which the exudation exerts upon the nerve elements of the retina.

Muscæ volitantes are often abundant

when floating particles exist in the vitreous, which is commonly the case.

Peripheral vision usually presents scotomata corresponding to the patches of exudation.

Ophthalmoscopic Symptoms.—*Aspect.*—The exudations in the choroid are seen in the form of white patches upon the fundus; by preference they occupy the periphery or the position of the macula.

Form.—They have no preference of form, but are sometimes round, sometimes striated, and sometimes irregular in shape.

Colour.—They are of a dull, yellowish tint, less brilliant than the exudative patches of the retina, and much less so than patches of atrophy.

Number and Extent of Surface.—In certain cases they are very numerous, and not larger than a millet seed; in others, again, they are large, and extend over a considerable surface.

Borders.—Their borders melt insensibly into the normal tint of the adjoining choroid; sometimes they are surrounded with pigment.

Changes in the Neighbourhood.—In these cases hæmorrhages into the choroid are rare, but cloudiness of the vitreous is common.

The exudative choroiditis of Forster, which is characterized by large patches of exudation with pigmented margins, and during which the retina undergoes atrophy, is a variety of exudative choroiditis.

Causes.—In two-thirds of the cases syphilis is the cause; in others it is obscure. In females, sometimes, dysmenorrhœa, the climacteric period, or the puerperal state may produce it; or again, sympathetic ophthalmia, and severe hæmorrhages.

Diagnosis.—This will depend upon the answers we can give to the following three questions:—Is the white patch really an exudation of the choroid? What is its cause? Is the retina healthy or diseased?

Exudations of the choroid can only be mistaken for exudations situated in the deeper layers of the retina, or with patches of atrophy. We have before (Exudative

Retinitis) pointed out the bases of diagnosis in these cases.

As for the cause, that must be arrived at by a summary of the general condition of the patient. In any case syphilitic choroiditis disseminata follows ordinarily one type, which it is necessary to recognize.

1. It is usually localized in the posterior pole of the eye.

2. The exudation patches are small and numerous, grouped after the fashion of some skin affection, without tendency to run into each other.

3. The vitreous presents a cloudiness which appears and disappears suddenly in a periodical manner.

4. The disease has a great tendency to spread to the retina.

5. The most important indications are, nevertheless, furnished by the antecedents of the patient, the existence of old manifestations of syphilis in the eye, such as iritis, syphilitic paralysis of the muscles, neuro-retinitis, etc.

The retina, is it healthy or diseased? This is a question we should always ask ourselves,

so frequent is this complication. The condition of the retina is judged by the appearance of the vessels, by the presence of infiltration, and the colour of the papilla, which in these cases not infrequently atrophies and becomes white. What becomes of these exudations into the choroid? They cannot be absorbed without leaving traces of their previous existence, or giving rise to a patch of atrophy. They sometimes become cartilaginous or even osseous.

Prognosis.—This is not very serious as long as the exudations do not occupy the region of the macula, and as long as the retina does not participate in the changes; under other circumstances it is much more dangerous.

Treatment.—Locally, atropine, blisters. Generally, to remove the cause. If it be syphilitic, mercurial inunctions, iodide of potassium, etc.

ARTICLE III.

ATROPHIC CHOROIDITIS.

Is characterized by gaps, as though made by a punch, here and there in the choroid, the result of partial atrophy of its vessels. Through these apertures the white, mother-of-pearl-like tissue of the sclerotic is visible.

It is either *simple*, when only one or two patches exist; *disseminated*, when they are scattered about in large numbers; *pigmented*, when the whole fundus of the eye is covered with masses of pigment, but this has nothing in common with the choroido-retinitis pigmentosa of which we have previously spoken.

It is called peri-papillary when it forms a little white ring completely encircling the papilla. This is chiefly seen in aged people.

Functional Symptoms. — Its onset is very slow. Central vision usually remains intact. Patients complain of fatigue of the eyes and dazzling, because the absence of

choroidal pigment interferes with the proper absorption of light in the eye. If the macula is affected, the scotoma which results seriously compromises central vision.

Peripheral vision is rarely affected to such an extent as to prevent the patient going about.

Ophthalmoscopic Symptoms. — These are very characteristic, and enable us to follow the disease in all its phases.

At the commencement we see rounded spots of a pale rose colour, contrasting with the deeper red of the neighbouring parts. This condition corresponds with depigmentation of the layer of the chorio-capillaris.

At the next stage (depigmentation of the stroma) we see the large choroidal vessels becoming detached over the affected spot, on the borders of which are deposited little islands of pigment.

Finally, the larger vessels, in turn, become atrophied, the spot whitens, and a well-developed atrophic patch remains.

These patches present the following dis-

tinguishing characteristics:—They are white, and the retinal vessels pass *in front of them.* When numerous, they are chiefly scattered over the region of the posterior pole of the eye. By predilection their form is circular, and they always are round, or formed of a number of circles touching. They are of a white pearly colour, which is very characteristic. This colouring gives a more brilliant outline to the retinal vessels which pass in front. Upon their surface we often observe patches of pigment, or one or two branches of the vasæ vorticosæ, incompletely atrophied. As regards their number and extent nothing definite can be said. Sometimes the whole fundus is bestrewn with these little patches. Sometimes several join together, forming a very extensive surface. Their borders are usually clear and well defined, pigment, in the form of small islands, or in stripes, being deposited round their margins. The choroid, in the neighbourhood of these atrophic patches, is paler than usual, having lost part of its pigment. There is rarely any change in the vitreous body.

Causes.—These are generally very obscure. We may mention as most frequent—(1) syphilis; (2) disturbance of the uterine functions (dysmenorrhœa, amenorrhœa); (3) the rheumatic diathesis; (4) sympathetic ophthalmia. Atrophic patches of large extent may sometimes result from old exudations or hæmorrhages into the choroid.

Diagnosis.—The bluish or mother-of-pearl tint of these patches, and the presence of abundance of pigment in their margins and often on their surface, enable us to recognize this disease at a glance. We have before pointed out the different characters which enable us to distinguish them from exudations of the choroid and the retina (*see* Exudative Retinitis).

We must not mistake the deposits of pigment situated on the surface of these patches, or on their margins, for that infiltration of the retina with pigment which takes place in retinitis pigmentosa. The appearance of the pigmentation is not the same in the choroidal affection; we have large irregular

masses of pigment scattered over the fundus of the eye intermixed with large white patches. In the retinal affection they are little black points bound together with dark stripes which have their chief seat in the course of the vessels, principally in the region of the ora serrata. Further, in these cases we find none of the characteristic symptoms of retinitis pigmentosa, viz., hemeralopia, concentric contraction of the field of vision, diminution of the calibre of the large retinal vessels.

Prognosis.—It is the situation of the atrophic patch with regard to the macula which becomes the principal element in our prognosis. The atrophied tissue is never repaired, but as we have before stated, it sometimes interferes but slightly with vision.

Treatment.—We must try and prevent the spread of the disease and by warm douches to the eyes to increase the circulation. Blisters to the nape of the neck; stimulating inunctions round the orbit; a generally tonic treatment, together with iodide of potassium.

Blue or smoked glasses will prevent the dazzling which often annoys these patients.

ARTICLE IV.

SCLERO-CHOROIDITIS POSTICA—POSTERIOR STAPHYLOMA.

This is a variety of atrophic choroiditis special to the myopic eye. It is called *sclero-choroiditis postica*, because the sclerotic seems also thinned, and posterior staphyloma, because, owing to this thinning, it is generally accompanied by a certain amount of projection of the globe posteriorly.

Objective and Functional Symptoms.—These are those of myopia. In any case, the following symptoms point directly to the presence of a staphyloma.

The eye is elongated, and has manifestly an ovoid shape, which is easily seen on making the patient direct it forcibly inwards, and comparing it with a healthy eye.

Its mobility is diminished, for whilst in the normal eye the most extreme rotation inwards conceals the inner half of the cornea behind the commissure, and the most extreme rotation outwards brings the outer margin of the cornea to the edge of the commissure, such extensive movements are not possible in a myopic eye, the posterior pole of which impinges against the lateral walls of the orbit (Mayer).

The internal recti muscles are insufficient, consequently we often see an external strabismus supervene. In effect, the diminution of the mobility of the eye impedes the movements of convergence, which are the more indispensable to the myopic because they can only see objects which are very close. Further, the internal recti muscles, being always in action, soon become fatigued. The one which is the most feeble relaxes, producing immediately diplopia; the patient, by an additional effort, tries to overcome this. These efforts give pain and produce muscular asthenopia. In the end the patient involuntarily abandons binocular vision, the

weaker eye deviating outwards, in order that its vision may be excluded.

Ophthalmoscopic Symptoms. — These are very characteristic. The staphyloma is seen in the form of a large, brilliant, white, pearly patch, as in all cases of atrophy of the choroid. This is situated on the same side as the macula, that is, on the outer side of the papilla in the erect image, and on the inner side in the inverted; very exceptionally, it is situated above or below the papilla. Its shape is that of a crescent (first stage), of which the concavity embraces the vertical diameter of the pupil, and whose convexity is directed towards the yellow spot, to which it may sometimes even reach. This crescent sometimes assumes an annular form, encircling the papilla in its whole, or two-thirds, of its extent. This constitutes the second and third degrees of staphyloma, according to Desmarres. In other cases it may be so small as to constitute a narrow white border. The colour of the staphyloma is of a pearly whiteness, which increases the brilliancy of

the vessels which pass over it. Occasionally a small quantity of pigment is deposited on its surface, or we can perceive the traces of some of the choroidal vessels which have not quite disappeared. The borders are usually distinctly limited by a circular margin of pigment, which indicates the arrest of the disease. If the margins are irregular and surrounded by choroid that is paler than usual, it indicates that the malady is progressive.

These are the characters which the patch reveals as an *atrophic* patch. We recognize its *staphylomatous* nature by the following features:—

Change in the Direction of the Retinal Vessels.—The retinal vessels passing in front of it are rectilinear, and less tortuous than usual, on account of the pushing back of the retina, which participates in the staphyloma, the depression of which the vessels follow, and thus become straightened.

Change in the Appearance of the Papilla.—The papilla, having one of its sides involved in the staphyloma, is no longer seen in full, but more or less in profile, or

three-quarter view, and thus appears oval in the vertical direction, its breadth being contracted.

Change in the Dioptric Condition of the Eye. — With the mirror alone we see a real inverted image of the papilla and the retinal vessels. This image is recognized in that it appears to execute movements in the same direction as those of the globe, and opposite to those of the observer. (*See* Diagnosis of Anomalies of Refraction.)

Complications.—In these cases we often find the following complications:—

Patches of choroidal atrophy, either in the neighbourhood of the ora serrata or in the neighbourhood of the macula, where they necessarily produce central scotomata.

Partial fluidity of the vitreous body.

Floating bodies in the vitreous, due, probably, to minute extravasations of blood.

Photopsia, owing to the pressure to which the retina is subjected.

Opacity of the lens, owing to defective nourishment of the lens, or a diseased choroid.

Detachment of the retina, which brings about sudden loss of vision in the affected eye.

Glaucoma, when the sclerotic, becoming less elastic with age, will no longer yield to distension, and the hypersecretion of the choroid continues.

Cause.—The cause of sclero-choroiditis posticus, or myopia, is heredity. It is a disease of civilized races, resulting from the continual use of the eye upon close objects.

What chiefly characterizes this affection is a hypersecretion of the serosity, due to the choroid. It is this which gives rise to the posterior staphyloma. But how is it this staphyloma always occupies the outer side of the papilla? It is because at this spot, during fœtal life, there exists a solution of continuity (the hiatus scleroticus of Ammon). In myopia this weakened spot yields more readily than other parts to the intraocular pressure.

Diagnosis.—There can be no difficulty, unless in the following cases.

If the staphyloma is small, it may be mistaken (1) for an enlarged normal papilla. A little attention will enable us to distinguish a dark grey line which separates the disc from the staphyloma. (2) A physiological papilla with a double border. (3) A peri-papillary atrophy of the choroid, such as we often see in old persons and sometimes in glaucoma.

In these cases we shall avoid any mistake (1) by examining the sight with concave glasses.

(2) By examining the dioptric condition of the eye by means of the mirror alone.

(3) Opaque nerve-fibres in no way resemble staphyloma, as they conceal the retinal vessels and have their seat usually on the *external* side of the papilla, a staphyloma being on the *inner* side and lying behind the retinal vessels, which pass over its surface.

Progress.—Posterior staphyloma is either stationary or progressive.

Prognosis.—This depends upon the degree

of myopia, its progress, and the complications which are present. Generally, it is not serious, since almost all short-sighted persons exhibit a posterior staphyloma. The treatment will be that which is suitable for the myopia.

ARTICLE V.

SYPHILITIC CHOROIDITIS.

Syphilitic choroiditis may assume the form of exudative or atrophic choroiditis. A diagnosis is thus established by a knowledge of the antecedents or by the presence of diathetic manifestations, either in the structures of the eye or the other tissues of the body. But there is another variety of specific choroiditis with characteristics so marked as to deserve a separate description.

Functional Symptoms.—The commencement is slow. There are sensations of a mist which obscures objects, and the patient

compares this often to a thick spider's web floating before his eyes. Central vision is variously affected. Sometimes it is lost even at the commencement of the disease, owing to the compression to which the nerve elements are subjected. Peripheral vision often reveals circular scotomata around the point of fixation. The patient often is troubled with luminous impressions and flashes. There is usually some intolerance of light. Too much dazzles the eye, and yet a less quantity is insufficient to permit of reading. A certain amount of colour blindness exists generally. Yellow and blue are perceived with greatest difficulty; this is the reverse of what takes place in atrophy of the papilla.

The progress of the disease is marked by periods of aggression and retrocession. The patient will almost lose vision for nine or ten days without any corresponding ophthalmoscopic changes being seen; then, somewhat suddenly, vision returns.

The affection is usually monocular.

Ophthalmoscopic Symptoms.—General

cloudiness of the vitreous body, not absolutely hiding the ophthalmoscopic image, but deadening uniformally the brilliancy of the reflex. The papilla, although obscured, appears reddened, either as the result of some diffractive phenomenon, or because it is really congested.

Floating Bodies.—Their chief characteristic is that they are extremely fine, scarcely even visible, but they obscure vision by a sort of moveable cloud. When these bodies are of a larger size they usually, by preference, assume a circular form.

Choroid.—The choroid at first does not seem to undergo any change, but in the end, we find, either in the neighbourhood of the macula or the ora serrata, patches of exudation or atrophy, disposed in groups, which, however, exhibit no tendency to unite amongst themselves.

Retina.—The retina may participate in the disease, presenting symptoms of serous or exudative retinitis. The affection then assumes the name of specific choroido-retinitis. More frequently, however, the nerve structures become atrophied as well as the papilla, of

which we can obtain evidence by its whiteness and the diminution of the large vessels. Occasionally, pigment becomes deposited in the retina; we then have what is called syphilitic choroido-retinitis pigmentosa.

Diagnosis.—Here, cloudiness of the vitreous is the chief characteristic. It is never, however, sufficiently pronounced to prevent us seeing the papilla, but always present in a sufficient degree to mask its distinctness. This cloudiness is uniform, rarely accompanied by visible floating particles, and persists for a very long period.

The existence of specific manifestations in other structures of the eye gives a certainty to the diagnosis.

Prognosis.—This is very serious, because the disease has a tendency to spread to the retina. The cloudy condition of the vitreous usually lasts from twelve to fourteen months.

Treatment. — This consists in mercurial frictions and the administration of iodide of

potassium; instillations of atropine; blisters to the nape of the neck. Sulphur baths are useful adjuncts.

ARTICLE VI.

APOPLEXY OF THE CHOROID.

We described apoplexies of the retina under the name of retinitis apoplectica, because they usually accompany inflammatory changes of this membrane. Apoplexies of the choroid, on the contrary, more frequently appear as isolated accidents.

Blood extravasated from the vessels of the choroid may become effused (1) between the sclerotic and the choroid; (2) between the choroid and the retina, perhaps producing a detachment of the latter; (3) into the interior of the vitreous body; (4) into the thickness of the choroid itself. It is this latter condition which we shall here describe.

Functional Symptoms.—These may be

said not to exist if the hæmorrhage is peripherally situated. They resemble those of apoplexy of the retina if they occur in the neighbourhood of the macula.

Ophthalmoscopic Symptoms. — These are round red patches, situated in the region of the ora serrata, in front of which pass the retinal vessels.

When they are undergoing absorption they change colour, and on disappearing leave in their place a white atrophic patch bordered with pigment.

Causes.—These are accidents to the eye; diseases which offer an impediment to the general circulation, such as diseases of the heart and vessels; diseases which impede the local circulation (glaucoma, hydrophthalmia, sclero-choroiditis).

Diagnosis.—They are distinguished from apoplexies of the retina (1) by their seat being usually in the neighbourhood of the ora serrata; (2) by their rounded and non-

striated form; (3) by their situation *behind* the retinal vessels; (4) by the absence of all change in the retina.

Treatment. — This is the same as for retinitis apoplectica.

ARTICLE VII.

RUPTURE OF THE CHOROID.

A CONTUSION of the eye may produce a rupture of the choroid. At the moment, the effusion of blood is too great to enable us to recognize the injury; but when it is re-absorbed, we can make out a large white patch bordered with pigment, and usually in the shape of a half-circle, concentric with the papilla, and generally passing through the macula. This white mark is nothing less than the sclerotic seen through the rent in the choroid.

The visual disturbance is considerable if the yellow spot is affected, or if there are any other injuries to the interior of the eye.

ARTICLE VIII.

DETACHMENT OF THE CHOROID.

This affection, which is very rare, may be produced by a tumour situated between the choroid and the sclerotic, or by an effusion of blood.

We see at the fundus of the eye a kind of spherical tumour of a deep red colour. There are no folds upon it, and it does not oscillate or vibrate with the movements of the eye. The retinal vessels pass in front of it, and behind them, on a different level, we can sometimes recognize the choroidal vessels.

The retina may be also slightly detached; if this is considerable, the diagnosis becomes most difficult. We must then take into consideration the deep colour of the tumour and the antecedent history.

Visual disturbance is usually very great, and the affection often terminates in irido-choroiditis, which leads to phthisis of the globe.

ARTICLE IX.

TUMOURS OF THE CHOROID.

Tumours of the choroid are almost always sarcomata.

Varieties. — 1. Sarcoma of ciliary circle. 2. Sarcoma of the deeper portions.

Objective Signs. — In sarcoma of the ciliary circle there is often a peri-corneal redness, corresponding to the spot where the sarcoma is developing. The anterior chamber is diminished in depth at the spot where the sarcoma is growing, owing to the iris being pushed forward. The iris may be detached from its ciliary connexions. Tension of the globe is increased, and the stage of glaucoma soon supervenes.

Ophthalmoscopic Signs. — With the mirror we may see a black rounded tumour springing up behind the iris and impinging

upon the pupillary space. The retina is not detached, for in the region of the ora serrata it has very intimate connexions with the choroid.

In sarcoma of the deeper portions, the commencement is slow and insidious, without pain, without change in the external aspect of the eye; the sight often is inappreciably affected. De Graefe thought that there was almost always some serous infiltration of the retina, but considered diagnosis at an early stage almost impossible. At a later period, detachment of the retina takes place; this detachment masks the tumour, and is with difficulty distinguished from a simple detachment. In many cases, in spite of the detachment, we can make out behind the retina capillary vessels of recent formation, and differing from the vasa vorticosa. They are seated on the surface of the tumour, and are intermixed with black or white patches which are very apparent. Sometimes we see the condition known as "cat's eye," which is produced by the brilliant reflex of a detached and thickened retina. This is an excellent

sign, but it is one which is not infrequently wanting.

The tumour in growing fills the globe of the eye, enlarges it, spreads along the nerve, and ends by rupturing either the cornea or the sclerotic, and invading the neighbouring structures. At this time, the glaucomatous condition having ceased, a notable remission takes place in the pain. In some cases the eye atrophies, without, however, the tumour ceasing to spread. At this stage the patient exhibits all the symptoms and appearance of the cancerous cachexia. The liver is often affected, and death shortly supervenes.

Diagnosis.—1. *From Simple Detachment.*—When a detachment of the retina masks the tumour, and we have not that glistening reflex known by the name of "cat's eye," the diagnosis between tumour and simple detachment is very difficult. We must then take into consideration the following characteristics:—

1. The unusual seat of the detachment, which in ordinary cases is almost invariably below.

2. Its general appearance.—The undulatory movements of the detachment are more restricted, the mass of the tumour filling up the space behind it.

3. The rapidity with which it spreads.

4. The absence of the ordinary causes of detachment, such as myopia, traumatism, exudations into the vitreous body.

5. The tension of the globe.—It is a rule that in simple detachment the tension is invariably diminished, whilst in detachment complicated with tumour it is increased. This sign is of great value.

6. The presence of capillary vessels of new formation behind the retina.—This sign is pathognomonic, but often difficult to make out.

2. *From Glioma of Retina.*—In these cases the cat's eye reflex is the rule, whilst sarcoma of the choroid is generally masked by detachment; but in these cases the age of the patient is the most valuable diagnostic sign, glioma never occurring after the fifteenth year, and sarcoma never before this period, and usually between forty and fifty.

Progress.—This is very variable. As a rule, these growths take several years before they fill the globe and become generalized.

Prognosis is very serious, owing to the recurrent tendency of the tumour. They never, however, affect both eyes, as is sometimes observed with glioma.

Treatment consists in the enucleation of the eye, care being taken to divide the nerve at as great a distance from the globe as possible. If the disease has invaded the orbit, all the infected parts must be removed.

CHAPTER V.

AFFECTIONS OF THE VITREOUS BODY.

Affections of the vitreous body rarely have their origin in this medium itself, but usually proceed from other changes in the deeper structures of the eye, notably the choroid.

The changes in this structure relate (1) to its consistency; (2) to its transparency.

We shall thus describe:—

1. Softening of the vitreous body.
2. Floating bodies in the vitreous.
3. Apoplexy of the vitreous.
4. Foreign bodies in its structure (cysticercus).

ARTICLE I.

SOFTENING OF THE VITREOUS BODY.

When the vitreous body loses its normal density, which is gelatinous, and becomes liquified, the condition is called synchisis.

We may have *simple* synchisis when the vitreous retains its normal transparency; *complicated* synchisis, when, together with this fluidity, the vitreous is cloudy, and exhibits floating particles. The last condition can only, of course, be determined with the ophthalmoscope.

Simple Synchisis

Is either partial or total. It is often limited to the anterior or posterior portions of the vitreous body.

Objective Signs.—We observe tremulous movements of the iris, especially at its periphery, when any movement of the eye takes place. This would not occur if the lens, which is the point of support for the iris, did not itself rock about, owing to the rupture and relaxation of its suspensory ligament. This symptom, though pathognomonic, is often absent.

Alterations in the Intraocular Pressure.— Softened eyes always contain a fluid vitreous; but hardness of the eye is not incompatible with this condition. It depends upon the degree of fulness of the globe. There are neither ophthalmoscopic nor functional symptoms, and vision is in no way necessarily altered.

Causes. — Total synchisis follows old choroiditis. Cases of this kind are frequently the result of penetration by foreign bodies, or forcible luxations of the lens. It not unfrequently follows the accidental loss of a considerable portion of the vitreous.

Partial synchisis is observed chiefly in the posterior segment in cases of myopia.

Diagnosis.—It can only be made when we find the objective signs we have before pointed out. In other cases, as those of partial synchisis, we only suspect there is softening of the vitreous by a knowledge of the presence of the conditions which usually give rise to it.

Prognosis.—It is not serious in itself, but in the event of operations having to be performed upon these eyes, the escape of fluid vitreous is much to be feared.

ARTICLE II.

FLOATING BODIES IN VITREOUS.

Complicated Synchisis.

We designate by this name, moveable bodies, visible with the ophthalmoscope, which float in the more or less liquefied vitreous body.

They may be of different kinds, and we distinguish—

1. Fine powdery particles, sometimes arranged like a delicate spider's web.
2. Larger dark flakes.
3. Membranous particles.
4. Particles of cholesterine.

I.—Powdery Particles.

When these exist the patient has continually before his central vision a kind of

spider's web, which obscures objects. The visual disturbance is much more marked than when the particles are larger, for these always have between them transparent intervals. Peripheral vision is rarely interfered with.

Ophthalmoscopic Symptoms.—Particles as fine as minute dust are frequently not visible, unless they are mixed up with larger opacities. By their union they seem to produce a greyish cloud, susceptible of a certain amount of displacement, and veiling the fundus of the eye. We get the best view of them by using the mirror alone, with a feeble illumination.

The papilla, seen through this cloud, always appears redder than normal. This is produced by diffraction of light, analogous to what we observe in looking at stars through an atmosphere charged with vapour.

Causes.—They are due to a disturbance of the nutrition of the vitreous body, the result of a pre-existing choroiditis, or to the

migration of inflammatory elements furnished by a diseased choroid.

We see them chiefly in cases of syphilitic choroiditis, of which they are in a measure characteristic.

Diagnosis.—The general disturbance of the vitreous body veils the ophthalmoscopic image, and might lead us to believe that œdema of the retina existed. We have before pointed out the differential diagnosis.

II.—Larger Black Floating Particles.

Functional Symptoms.—The commencement is often somewhat sudden.

Central Vision.—When there are only one or two particles the patient can generally continue to read and write. He complains of little bodies like flies floating before his eyes. When a considerable number exist, he sees for a moment the word upon which vision is fixed, then it suddenly disappears. He instinctively raises the head and the eye at

each moment as if to displace the floating bodies from the point of fixation. This movement is characteristic.

Vision in the early morning is ameliorated by the repose of the eyes during the night and the accumulation of the floating particles in the most dependent portion of the vitreous.

Peripheral Vision is retained.

Ophthalmoscopic Symptoms.—To see these floating bodies we should use the mirror by itself, illuminating the fundus whilst the eye is moved in different directions. It is better to vary our distance from the patient, sometimes approaching closely, then retiring further off; in this way we illuminate the different strata of the vitreous, and the observer is enabled to see the red field of the fundus traversed by the little black corpuscles, which move with a degree of rapidity proportional to the fluidity of the vitreous.

Causes.—They are due to little effusions of blood which come rarely from the retina,

but usually from the anterior parts of the choroid. It is at this spot that the choroid is most vascular, and is only separated from the vitreous by the hyaloid membrane, the retina being reduced to a few fibres of cellular tissue. We can sometimes recognize where a rent has taken place by the presence of a little white spot bordered with pigment.

These little effusions of blood are of frequent occurrence in myopia, in different forms of choroiditis, and in disturbances of the general circulation (suppressed hæmorrhoids, suppression of the menses, etc.).

Diagnosis.—We must not mistake these bodies for *opacities seated in the crystalline lens.* These always move with the lens, but the same position of the eye always brings them to the same place. Particles in the vitreous, on the contrary, move in all directions and in an irregular manner. Lateral illumination will always detect opacities in the lens, but not in the vitreous. Physiological muscæ are never visible with the ophthalmoscope.

Scotomata have a fixed place, which never

changes its relation to the point of fixation; it depends usually upon some appreciable alteration in the deeper structures.

III.—Membranous Opacities.

Functional Symptoms.—The onset is slow. Central vision is always more or less compromised. Peripheral vision is lost on the side opposite to that on which the false membranes are situated.

Ophthalmoscopic Symptoms.—As their name indicates, they are, in reality, true false membranes, frequently rolled up upon themselves, at times completely adherent, at other times fixed at one extremity, the other floating freely.

Causes.—These membranous bodies have their origin in fibrinous deposits, the results of considerable effusions of blood, or are the remains of old exudations deposited in the vitreous body by some antecedent choroiditis.

Diagnosis. — Extensive false membranes, seated in the most dependent parts of the vitreous, might lead to the supposition of detached retina. We have above pointed out the elements of diagnosis (*see* Detachment).

IV.—Cholesterine Scales (*Sparkling Synchisis*).

Functional Symptoms.—The patient has before his eyes numerous muscæ volitantes, or there is the appearance of a cloud which obscures vision.

Ophthalmoscopic Symptoms. —These crystals reflect strongly the light, and are seen in the form of little golden or silver scales floating in the vitreous body. One sees in the vitreous a miniature shower of golden particles. Sometimes these crystals are mixed with other floating bodies, to which they may adhere.

Causes.—They come from the precipitation in the solid form of the salts of cholesterine,

normally contained in a state of solution by the vitreous body; the reason is as yet unexplained. They frequently coincide with dislocation of the lens and with detachment of the retina, but they may also be observed in eyes which exhibit no trace of disease.

Prognosis of Floating Bodies in general.—The black particles which result from effusion of blood are sometimes absorbed; membranous bodies which result from exudation are long in passing away, and bespeak some great change in the choroid. Those which appear in the form of minute dust, or powder, and result from specific choroiditis, are frequently one or two years before they disappear. The cholesterine scales rarely disappear, but remain permanent.

Treatment.—Attention must be directed to the diseased condition of the choroid, which is the usual cause of floating bodies.

To help their absorption, iodide of potassium internally is advisable. Warm douches are a useful adjunct. The patient should wear

blue spectacles to conceal the muscæ, which are usually very annoying.

ARTICLE III.

GENERAL APOPLEXY OF THE VITREOUS BODY.

This is an affection which is characterized by an effusion of blood sufficiently large to fill a considerable portion of the vitreous chamber. It is merely in the amount effused that it differs from those attacks which produce the floating particles we have before been treating of.

Functional Symptoms.—The attack is rapid, sudden, and painless. Central vision is immediately abolished, to such an extent even that night and day are indistinguishable. Peripheral vision is equally lost. The distinction of phosphenes remains, the retina behind the effusion being still functionally active. The affection is always monocular.

Ophthalmoscopic Symptoms.— It is

impossible to illuminate the fundus of the eye; we only get a black reflex from the pupil.

With the mirror alone, and sometimes with oblique illumination, we may distinguish a reddish colouring in the deeper portions of the eye, especially if the blood is situated in the anterior portions of the vitreous close behind the lens.

Causes.—These must be looked for—

1. Amongst disturbances of the general circulation (disease of the heart, suppression of the menstrual flow, or, again, suppressed hæmorrhoidal discharge).

2. In disturbances of the local circulation (glaucoma and irido-choroiditis).

3. In the sudden diminution of intraocular pressure; above all, when it has previously been in excess, as in iridectomy after glaucoma.

Pathological Anatomy. — In a large majority of cases the blood comes from the anterior vessels of the choroid, at which spot this structure is most vascular. To penetrate

into the vitreous body, the blood has only to traverse the retina and hyaloid membrane, the former already much thinned.

The retinal vessels are much smaller in calibre than those of the choroid. When they give way the internal limiting membrane of the retina opposes the passage of blood into the vitreous cavity and favours its infiltration into the thickness of the nervous structures. For these reasons apoplexies of the vitreous body rarely result from hæmorrhage from the retinal vessels.

Diagnosis.—The sudden loss of central and peripheral vision, with the retention of the power of recognizing the different phosphenes, form a group of symptoms which are in themselves pathognomonic. These three symptoms taken together will enable us to distinguish between this and other diseases in which there is equally sudden loss of vision in one eye (*see* Embolism).

If we take as the basis of our diagnosis the symptoms which the ophthalmoscope presents, we shall see that they are equally

characteristic. The absence of all reflex through the pupil could only be met with in cases of black cataract, or, perhaps, in some forms of extensive detachment. In the former case lateral illumination always enables us to make out the striation of the lens; in the latter the reflex is more grey than black, and we are usually able to make out vessels passing over the detached retina.

Prognosis.—Apoplexy of the retina may clear up at the end of ten or twelve months, if no recurrence should take place. In any case it always leaves floating bodies in the vitreous and other indelible traces of the effusion.

Experience proves that hæmorrhage into the anterior portion of the vitreous is less serious than into the posterior portion. The reason of this is that the former is in intimate relation with the ciliary vascular circle, which greatly favours its rapid absorption.

Treatment.—To produce absorption we employ alternately collyria of atropine and

eserine, stimulating embrocations round the orbit, blisters to the nape of the neck.

To prevent a recurrence of hæmorrhage we should advise leeches to the anus, slight purgatives, in some cases digitalis, and in females the encouragement of the menstrual flow.

ARTICLE IV.

FOREIGN BODIES IN THE VITREOUS CHAMBER.

When a foreign body has penetrated the vitreous chamber (such as a piece of a gun cap, a leaden shot, etc.) it usually soon sinks into the most dependent portion. We can then often see it with great distinctness with the mirror alone, the crystalline lens playing the part of a magnifying glass, and enlarging its dimensions.

After a certain length of time it becomes surrounded with plastic lymph and encysted, or else it sets up suppurative choroiditis.

When it is encysted it may remain for a long time in the eye without setting up any

serious disturbance. Not unfrequently after many years these disturbances arise, and the other eye may even become sympathetically affected.

ARTICLE V.

CYSTICERCUS IN THE VITREOUS.

Cysticercus in the vitreous has been of rare occurrence in France and in England, but much more common in Germany. These are its principal characteristics:—

A small transparent vesicle is seen in the vitreous; it is ovoid in form, of a bluish-white tint, usually fixed, but sometimes executing slight oscillations when the eye is moved. In some cases we may at times distinguish at one extremity of the vesicle the head and neck of the animal.

The vitreous body becomes cloudy, the retina detached, and often irido-choroiditis is set up, which leads to atrophy of the globe.

CHAPTER VI.

ON AMBLYOPIA OR AMAUROSIS PROPERLY SO CALLED.

Under this heading we distinguish all those cases of enfeebled vision in which no appreciable ophthalmoscopic lesion is visible. According to their originating cause we may distinguish the following varieties :—

1. Cerebral amblyopia and amaurosis.
2. Toxic amblyopia.
3. Glycosuric amblyopia.
4. Hysteric amblyopia.
5. Reflex amblyopia.
6. Amblyopia through want of use.
7. Simulated amblyopia.

Cerebral Amblyopia and Amaurosis.—We may observe it under three principal headings.

1. The loss of vision may be progressive.

Our attention will then be directed to possible atrophy of the papilla, which often does not become whiter till after several months have elapsed.

2. Loss of vision may be immediate or very rapid. This may be due to some disturbance of the circulation in the brain (spasm of the vessels), and may be only transitory. If it does not pass off, the papilla will soon give evidence of it.

3. There may be loss of vision in some portion of the field only, in the form of hemiopia. Under these circumstances, the disturbance may be long in existence without there being any appreciable alteration in the papilla (*see* Hemiopia.)

Toxic Amblyopia may be dependent upon alcohol, nicotine, lead, urea, etc. The most frequent cause is alcohol. The functional symptoms resemble very much progressive atrophy; there are no marked ophthalmoscopic signs.

Alcoholic amblyopia usually comes on suddenly. Central vision is rapidly diminished

to such an extent that the patient can with difficulty make out little of No. 10 or 15. Peripheral vision is not disturbed. There is always a certain amount of nyctalopia. The distinction of colours is often lost or much diminished, and the patient finds a difficulty in recognizing gold coins from silver. There are sometimes strange hallucinations of sight, which consist in seeing objects apparently approaching or retiring, or, again, larger or smaller than they should be.

The progress of the disease is usually intermittent, and both eyes are affected in an equal degree. There are general symptoms of chronic alcoholic poisoning, such as congestion of the pituitary membrane, tremblings of the limbs, nightmare, diplopia from spasmodic contractions of the muscles of the eye.

Glycosuric Amblyopia is most frequently seen in the form of hemiopia, or concentric contraction of the field of vision. Analysis of the urine can alone confirm the diagnosis.

Hysterical Amblyopia.—Amblyopia of one eye, and chiefly the left, is the most common form. It is often accompanied by analgesia of the corresponding side.

We may meet with amblyopia of both eyes in the form of hemiopia, or even complete amaurosis, following intractable hysterical attacks. The peculiarity of these affections is their sudden advent and their equally sudden disappearance.

Reflex Amblyopia.—In this group are gathered those forms of amblyopia or amaurosis which follow a slight shock to the eye or prolonged irritation of the fifth nerve (a cicatrix involving the infra-orbital nerve, carious teeth). In the latter case, extraction may restore vision.

Amblyopia from Disuse.—When an eye squints, and no longer plays a part in vision, the sight becomes enfeebled without the ophthalmoscope revealing any sign of change. Methodical exercises with magnifying glasses give excellent results in these cases.

Simulated Amaurosis.—Amaurosis of both eyes is rarely simulated on account of the amount of trouble it would give to any one practising this deception, but monocular amaurosis is frequently feigned, especially in countries where conscription for the army is compulsory. The best means for detecting this fraud are as follows:—

1. The pupil reacts well under the influence of light. If it is dilated with atropine, the dilation is always greater than in genuine amaurosis.

2. The patient, in fixing the finger at 10 or 15 centimetres, will exhibit no divergent strabismus. In real amaurosis there is almost always some deviation outwards of the amaurotic eye. But we must not forget that every external strabismus is not necessarily accompanied by amaurosis.

3. We place before the healthy eye of the patient, the supposed amaurotic eye being open, a prism of 10 or 15 degrees, with its base turned either upwards or downwards. If the patient sees two images of the same object, it proves that

both eyes see, and deception is at once established. If the suspected person does not confess to seeing two images, we place before his eye a doubly refracting lens, which produces a distinct *monocular* diplopia, and we shall thus ascertain if his answers have been correct.

4. Dots are traced upon a piece of paper, with an interval of one centimetre; this is placed at the limit of distinct vision of the patient. If the finger or a ruler is interposed between the eye and this test paper, all the dots will be seen if there is binocular vision. In the event of the sight of one eye being lost, some of them will not be perceived. It is easy to try this experiment upon oneself, and to observe what conclusions we can draw from it (Method of Cignet).

5. A Dutch physician, Dr. Flees, has constructed a little apparatus, in which the patient sees with his right eye what he thinks he sees with his left, and *vice versâ*. This is done by mirrors which reflect the images. Simulation may easily be detected by this instrument.

CHAPTER VII.

DIAGNOSIS OF ANOMALIES OF REFRACTION.

The ophthalmoscope may serve as an optometer, and furnish us with an elegant method of diagnosing anomalies of refraction, which we can thus recognize without questioning the patient, and without having recourse to correcting lenses.

The method employed consists in illuminating the eye with the mirror alone, and without the object lens. When, under these circumstances, we can see clearly the image of the papilla or the retinal vessels, we may be certain that the eye is *ametropic*, either myopic or hypermetropic.

The Myopic Eye. — Here theory teaches us that the image that we see is a real image, inverted, and situated in front of the examined eye. This we can establish

by watching the apparent movements which it executes under the following conditions:—

If the observer, fixing upon some vessel in the field, moves his head gently to the *right*, the image of the vessel will appear to be displaced to the *left*, and *vice versâ*. To sum up: The image will always appear to execute movements in a direction *opposite* to the observer. If, on the contrary, the observer remains stationary, and the eye we are observing moves, the image of the vessels will execute movements in the same direction as the globe.

As the image is situated in front of the examined eye, the observer will only see it clearly when he is at a certain distance from it; the nearer he comes the less distinctly he will see, and when he is close he will not be able to see it at all.

Hypermetropic Eye.—Here the image that we see is erect, virtual, situated behind the examined eye, and consequently behind the plane of the iris. In this case, when the observer moves to the *right*, the image also

moves to the *right*, and *vice versâ*—that is to say, it executes movements in the *same direction* as the observer. When the observer remains stationary and the eye is moved, the image of the retinal vessels execute movements in a direction opposite to that of the globe.

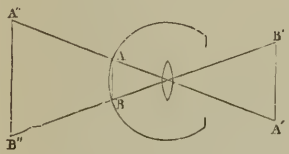

FIG. 16.

Thus, in the movement of elevation of the globe the point B is lowered, together with its virtual image.

As the image is situated behind the examined eye, the nearer the observer approaches the more clearly he sees the image, which is the reverse of what takes place in myopia.

Degree of Ametropia.—When once we

have made out that hypermetropia or myopia exists we should measure its degree.

Myopia. — To test this, we place behind the aperture of the ophthalmoscopic mirror concave glasses, gradually increasing in strength. The effect of these glasses is to diminish the convergence of the rays emanating from the myopic fundus. When we arrive at a glass which renders these rays parallel, we get a distinct image of the fundus and a measure of the degree of myopia.

Hypermetropia. — The same method is pursued, but here we make use of convex glasses. The rays emanating from the hypermetropic eye are divergent, and the convex lens which renders them parallel enables us to see the fundus clearly, and gives, at the same time, a measure of the hypermetropia. These tests are capable of great precision, but they necessitate that the observer shall be emmetropic, or that his ametropia has been corrected with suitable glasses, and that he should be able to suspend his accommodation.

Astigmatism.—The ophthalmoscopic diagnosis of astigmatism requires very delicate power of observation.

As the vertical and horizontal meridians of the eye have not the same power of refraction, the observer, placed at a given distance, can see the superior and inferior limits of the papilla, whilst the lateral margin will be indistinct, and *vice versâ*.

For the same reason he sometimes sees the retinal vessels which follow one direction, whilst he is obliged to come nearer or go further off before he can distinguish those which are perpendicular to the first.

The papilla seen in the inverted image will appear oval, with its major axis vertical, if the vertical meridian has the minor degree of curvature. Seen in the erect image it will appear as an oval with its major axis horizontal. These two tests are necessary to institute the certain existence of astigmatism (Knapp).

In mixed astigmatism we may see the retinal vessels displaced in the *same direction* as the movements of the eye when it is

moved up and down, and inversely when it is moved from right to left.

This indicates myopia of one meridian and hypermetropia of the other.

In irregular astigmatism (staphyloma pellucidum) the papilla changes its shape momentarily, sometimes appearing drawn out in one direction, sometimes in another.

As to the degree of astigmatism, this is usually better measured with cylindrical glasses than with the ophthalmoscope.

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